MODEL 5000

LIQUID CHROMATOGRAPH

OPERATORS MANUAL

varian
instrument division

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MODEL 5000
LIQUID CHROMATOGRAPH
OPERATORS MANUAL

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PUBLICATION NUMBER 03-913807-00 PRINTED IN U.S.A. JUNE 1978

Varian's Warranty for Instrument Division Products

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All standard Instrument Division Products sold by Varian are warranted for a period of one (1) year to be free of defects in material and workmanship in accordance with the terms set forth below. Varian's obligation under all warranties is limited in accordance with the periods of time and all other conditions stated in all provisions of this warranty, including the periods and conditions provided in the special warranty statements applicable to Special Products, Custom Products, Accessories, and Prorated Items.

Warranty Period

The applicable warranty period shall begin on the date of shipment from Varian to the original purchaser. Where, however, Varian specifically agrees in writing to provide installation of its Products, the applicable warranty period shall begin upon completion of such installation. Upon beginning of the applicable Varian warranty period, all Customer's remedies shall be governed by the provisions stated in this warranty. In no event shall such warranty period extend more than fifteen (15) months from the date of shipment of the Product.

Warranty Coverage

The following statements and limitations are intended to clarify Varian's warranty coverage:

1. This warranty applies only to defects in material and workmanship in covered Products and is not to be interpreted as providing full service coverage for such items as routine maintenance, adjustments, or recalibration as defined by the instruction manual. Except as otherwise provided herein, Varian warrants that its covered products are merchantable for the applicable warranty periods stated herein.

2. This warranty covers only parts and labor furnished by Varian on Products and Accessories of its own manufacture. Some accessories, however, which are not manufactured by Varian are specially warranted by Varian as provided below under *ACCESSORIES*. Except as specially extended by Varian in writing in accordance with the *ACCESSORIES* provision below, Varian makes no warranty whatsoever concerning Products or Accessories not of its manufacture. Accessories not manufactured by Varian may be repaired or replaced according to the original manufacturer's warranty terms, if any, but Varian accepts no responsibility for failure of the original manufacturer to perform under its own warranty obligations.

3. The following are expressly **not covered** under warranty:

a. Any loss, damage, and/or instrument malfunction relating in any way to:

- shipping or storage;
- accident, abuse, alteration, misuse, or neglect;
- breakage or abuse of parts;
- operation other than in accordance with correct operating procedures;
- tampering with the system (e.g., modification or tampering with one part of the instrument can, in some cases, affect another part of the instrument);
- gas leaks caused by normal lab usage;
- lack of routine care and maintenance, such as lubrication and cleaning, as indicated in the instruction manual;
- inadequate utility service, failure of electrical or other energy supplies, incorrect physical environment, or other inadequate facilities or utilities as indicated in the instruction manuals and/or pre-installation instructions; and
- chemical action or contamination. NOTE: Varian products are constructed of materials selected for maximum durability consistent with product performance under normal usage; however, certain chemicals, alone or in combination, may react with or otherwise damage the Varian product or its components. Damage and/or malfunction resulting from this or other chemical action or contamination are expressly not covered by this warranty.
- deterioration of optical surfaces.

b. Products, Items, parts, accessories, subassemblies, or components which are expendable in normal use or operation of the instrument, or those of limited life, such as but not limited to filters, glassware, instrument status lamps, glass accessories, septa, columns, fuses, chart paper and ink, probe inserts, matching networks, sample tubes, glass lined tubing, pipe and tubing fittings, Variable Temperature Dewars, and transfer lines, unless specifically covered by an express warranty, extended to the Customer by Varian in writing.

Varian reserves the right to revise the foregoing list of what is not covered under warranty.

4. The sole and exclusive remedy under this warranty shall be repair of instrument malfunctions which in the sole opinion of Varian are due or traceable to defects in original materials or workmanship, or at Varian's option, replacement of defective parts. Provided that, Varian may, as an alternative, elect to refund an equitable portion of the purchase price of the Product.

5. In-warranty repaired or replacement parts or Products are warranted only for the remaining unexpired portion of the original warranty period applicable to the repaired or replaced parts or Products. Repair or replacement of Products or parts under warranty does not extend the original warranty period.

6. After expiration of the applicable warranty period, and in accordance with Varian's standard Service Agreement, Varian will provide service for which the Customer shall be charged at Varian's then current price for parts, labor, and transportation. Any obligation Varian may have to provide service and/or parts for discontinued products shall cease five (5) years after the manufacture of such products has been discontinued.

Warranty Replacement and Adjustment

All claims under warranty must be made promptly after occurrence of circumstances giving rise thereto and must be received within the applicable warranty period by Varian or its authorized representative. Such claims should include the Product type and serial numbers, and a full description of the circumstances giving rise to the claim. Varian reserves the right in its sole discretion to determine whether repair under valid warranty claims shall be made by (a) sending a field service engineer to the site, (b) having the Customer send the defective part, assembly, or instrument to a service shop or facility as authorized by Varian, or (c) authorizing the Customer to return the same to Varian. Warranty service on Products sold to U.S. customers for delivery in the U.S. will be performed only in the U.S. Before any Products, parts, or assemblies are sent to a service shop or facility or are returned to Varian for repair and/or adjustment, written authorization from Varian or its authorized representative for the return and instructions as to how and where the same should be shipped must be obtained. Any Product, part, or assembly sent to an authorized service shop or facility or returned to Varian for examination shall be sent prepaid via the means of transportation indicated as acceptable by Varian with all transportation at the expense of Customer. Varian reserves the right to reject any warranty claim not promptly reported and any warranty claim on any item that has been altered or has been shipped by non-acceptable means of transportation. When any Product, part, or assembly is sent to a service shop or facility or is returned to Varian for examination and inspection, or for any other reason, Customer shall be responsible for all damage resulting from improper packing or handling, and for loss in transit, notwithstanding any defect or non-conformity in the Product, part, or assembly. In all cases, Varian has sole responsibility for determining the cause and nature of failure, and Varian's determination with regard thereto shall be final.

Liability Limitations

Reasonable care must be used to avoid hazards. Varian expressly disclaims responsibility for loss or damage caused by use of its products other than in accordance with proper operating procedures. **IN NO EVENT SHALL VARIAN BE LIABLE FOR INCIDENTAL, CONSEQUENTIAL, OR RESULTING LOSS OR DAMAGE OF ANY KIND, HOWSOEVER CAUSED. VARIAN'S LIABILITY FOR DAMAGES SHALL NOT EXCEED THE PAYMENT, IF ANY, RECEIVED BY VARIAN FOR THE UNIT OF PRODUCT OR SERVICE FURNISHED OR TO BE FURNISHED, AS THE CASE MAY BE, WHICH IS THE SUBJECT OF CLAIM OR DISPUTE.**

All obligations of Varian under this warranty shall cease in the event its products or parts have been subject to accident, abuse, alteration, misuse or neglect, or which have not been operated and maintained in accordance with proper operating procedures.

All products and services provided within the scope of this warranty must be provided through, or with the knowledge and approval of, Varian. Varian makes no warranty concerning services or components supplied through unapproved sources. What constitutes an approved source shall be determined solely by Varian.

THIS WARRANTY IS EXPRESSLY IN LIEU OF AND EXCLUDES ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO WARRANTIES OF FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION, AND ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF VARIAN, UNLESS SUCH OTHER WARRANTIES, OBLIGATIONS, OR LIABILITIES ARE EXPRESSLY AGREED TO IN WRITING BY VARIAN.

Statements made by any person, including representatives of Varian, which are inconsistent or in conflict with the terms of this warranty, shall not be binding upon Varian unless reduced to writing and approved by an officer of Varian.

No action, regardless of form, arising out of, or in any way connected with, the Products or services, furnished or to be furnished by Varian, may be brought by the Customer more than one (1) year after the cause of action has accrued. All patent liability of Varian shall be determined solely in accordance with the standard Terms and Conditions of Sale of Varian.

Special or Custom Products

Special Products or Custom Products are those which require design modification or state-of-the-art technology and do not have extensive testing or long development cycles. Varian makes every reasonable effort to use the highest standards of engineering and design for such products. However, in lieu of the one (1) year period applicable to Varian Instrument Division standard Products, Varian warrants Special Products and Custom Products and/or the Special Product and Custom Product portion(s) of a system only against defects in material and workmanship for a period of ninety (90) days from the date of shipment and makes **NO OTHER WARRANTY WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING NO WARRANTY OF MERCHANTABILITY AND NO WARRANTY OF FITNESS FOR PARTICULAR PURPOSE, USE, OR APPLICATION.** In particular, but not by way of limitation, Varian shall have no warranty responsibility whatsoever for engineering, design, research or development work, technical information and assistance, or alterations and modification work related to the foregoing. Except to the extent modified in the immediately preceding sentences, all the terms and conditions stated in all provisions of this warranty applicable to standard Varian Instrument Division Products shall apply to Special Products and Custom Products.

Accessories

In lieu of the one (1) year period applicable to Varian Instrument Division standard Products, Accessories manufactured by Varian are warranted to be free of defects in material and workmanship for a period of ninety (90) days from the date of shipment, or if Varian specifically agrees in writing to provide installation, ninety (90) days from the date of installation. Provided, however, that certain Accessories, including some not manufactured by Varian, may be warranted by Varian for the specific items and periods expressed in writing on Varian special warranty statements, published price lists, and/or individual quotations. All such Accessory warranties extended by Varian are limited in accordance with all the terms, conditions, and other provisions stated in this warranty. Customer should not expect the installation of an Accessory to upgrade the performance of a Product which performed marginally or poorly prior to the Accessory installation. Accordingly, any warranty on an Accessory furnished by Varian shall not be construed to cover the instrument or other product with which it is used or to which it is attached, nor shall any such warranty provide for service or repair of malfunctions to such instrument or other product.

Prorated Items

For some Products, items, parts, Accessories, subassemblies, or components which are expendable in normal use or operation of the instrument, or are of limited life, and are specifically covered by an express warranty extended to the Customer by Varian in writing, the period of warranty coverage is prorated. Prorating the warranty is a method of sharing the warranty risk with the Customer. A prorated warranty is generally extended for a number of months or days after shipment, or of ownership after installation or for a number of hours of actual use by the Customer. If failure occurs within the periods provided, the part or other item specifically covered will generally be replaced on an exchange basis with issuance of a credit. That is, upon return of the defective part or item to Varian, a credit will be issued as a percentage of the original charge in accordance with the scale indicated or the schedule established as part of the warranty. Upon the first expiration of an alternate period of proration provided, Varian shall have no further warranty obligation with regard to prorated items.

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Varian Instrument Division Products are manufactured by
Varian Associates, Inc. / Headquarters: 611 Hansen Way, Palo Alto, California 94303 / (415) 493-4000

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Varian Special Warranty Statement

Accessories and Prorated Items

The following accessories and items are warranted for the specific periods indicated below. All the terms and conditions stated in all provisions of Varian's Warranty for Instrument Division Products shall fully apply to such accessories or items.

The warranty period will begin on date of shipment or if Varian personnel provide installation, from the date of installation.

Chromatography Products	**Warranty Period**
Auto Sampler	1 year
Hydrogen Generator	1 year
CDS-111	1 year
Pyroprobe	90 days
Recorders	1 year
LC Water Bath	1 year
Chromatography Detectors	90 days
Liquid Chromatography Flow Cells	90 days
Varichrom VUV/10	1 year
LC Fraction Collector	90 days
Rotary Valves	90 days
Source Lamps	90 days
Photomultiplier Tubes	90 days
Capillary System	90 days
Fluorichrom Detector	1 year
Techtron Products	
Auto-5 Cell Programmer	1 year
Wavelength Programmer	1 year
Auto-50 Sample Changer	1 year
Model 135-1 Chart Recorder	1 year
IM-6D Digital Indicator Module Kit	1 year
Diffuse Reflectance Accessory	1 year
Temperature Readout Accessory	1 year
Gel Scanner Accessory	1 year
Total Fluorescence Accessory	1 year
BC-6 Background Corrector	1 year
Background Correction Kit	1 year
M-80 Automatic Gas Control Kit	1 year
M-40 Supplemental Lamp Power Supply	1 year

Techtron Products	Warranty Period
M-63 Carbon Rod Atomizer	1 year
M-90 Carbon Rod Atomizer	1 year
DA-35 Data Acquisition System	1 year
Hollow Cathode Lamps	2 years
Nebulizers	90 days
Deuterium UV Source Lamps	90 days
Photomultiplier Tubes	90 days
EDL Power Supply	90 days
Model 37 Printer	90 days
HP9815A Calculator	90 days
ASD 53 Auto Sample Dispenser	1 year

Optics Products	
Recorder Module to convert Cary 118A to 118B	1 year
Wavelength Scanning Module to convert Cary 118B to 118C	1 year
Recorder and Scanning Module to convert Cary 118A to 118C	1 year
Automatic Sample Changer	1 year
Dual Automatic Sample Changer	1 year
Cell Turret	1 year
Multi-Flow Cell Adapter	1 year
Multi-Zero Suppression Accessory	1 year
Dual Wavelength Drive Accessory	1 year
Digital Repetitive Scan Accessory	1 year
Repetitive Scan Accessory	1 year
Fluorescence Accessory	1 year
Scattered Transmission Accessory	1 year
Diffuse Reflectance Accessory, Type I	1 year
PbS Detector Option for Reflectance Accessory	1 year
Diffuse Reflectance Accessory, Type II	1 year
Specular Reflectance Accessory	1 year
Universal Absorbance, % T Slidewire	1 year
Universal % T Slidewire	1 year
0-1, 1-2 Absorbance Slidewire	1 year
0-10, 0-100% T Slidewire	1 year
Linear Transmitting Potentiometer Attachment	1 year
Photomultiplier Tubes	90 days
Deuterium UV Source Lamps	6 mos. prorated
Xenon Source Lamp (SF 330)	90 days
Temperature Readout Accessory (219)	1 year
Digital Printer (SF-330)	90 days

Magnetic Products	
S-124 FT System	1 year
Teletypewriters	30 days
Magnetic Cassettes	90 days
Disk Systems	90 days
Flexible Discs	90 days
Line Printers	90 days
Klystron 9.5 GHz	2 yrs. prorated
Ion Source, EM-600	6 months
Air Pumps	90 days
Vacuum Pumps	90 days

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Important Notice

Customer Pre-Installation Obligations

For any installation of Products and/or accessories by Varian Service Engineers, the Customer shall be obligated to insure the availability of the appropriate utilities and the proper placing of equipment prior to the scheduled date of installation as indicated in the pre-installation instructions. If a Service Engineer is unable to complete a scheduled installation begun at the Customer's request due to inadequate facilities or inadequate utilities at the installation site, Varian shall charge the Customer for the additional time and expense involved in waiting for such facilities or utilities to become available. Such charges may be the normal extra charge involved in making a follow-up installation service call, the waiting time made necessary during the initial installation service call, and such other costs as may reasonably be incurred by Varian due to the unavailability of facilities and/or utilities appropriate to completion of scheduled installation services.

Varian Associates, Inc. Instrument Division, 611 Hansen Way, Palo Alto, California 94303 / (415) 493-4000

OPERATING INSTRUCTIONS

This instruction manual is provided to help you establish operating conditions which will permit safe and efficient use of your equipment. Special considerations and precautions are also described in the manual, but appear in the form of notes, cautions, and warnings as shown below. It is important that you operate your equipment in accordance with this instruction manual and any additional information which may be provided by Varian. Address any questions regarding the safe and proper use of your equipment to your nearest Varian Sales Office or Service Center. Refer to List of Sales Offices and Service Centers included in this manual.

NOTE

Information to aid you in obtaining best performance from your instrument.

CAUTION

Alerts you to situations that may cause equipment failure or damage, and how to avoid these situations.

WARNING

Alerts you to potentially hazardous situations that may cause personal injury, and how to avoid these situations.

THIS INSTRUMENT IS INTENDED FOR RESEARCH USE ONLY

NOT FOR USE IN FDA REGULATED IN VITRO DIAGNOSTIC PROCEDURES

SPARE PARTS AVAILABILITY

It is the policy of Varian to provide operational spare parts for any instrument and major accessory for a period of five (5) years after shipment of the final production run of that instrument. Spare parts will be available after this five (5) year period but on an "as available" basis.

Operational spare parts are defined as those individual electrical or mechanical parts that are susceptible to failure during their normal operation. Examples include resistors, inductors, capacitors, semi-conductor devices of all kinds, relays, lamps, temperature probes, detector elements, motors, etc.

Sheet metal parts, structural members or assemblies and castings, printed circuit boards, and functional modules are normally capable of being rebuilt to like-new condition throughout their useful life and therefore will be supplied on an "as available" basis only after the final production run of the instrument.

The repair and/or reconditioning of instruments and accessories is handled on a time and materials basis after expiration of the Warranty period. Please contact your nearest Varian Sales Office or Service Center for a quotation.

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Other Instrument Division Sales Offices and Representatives are located in Algeria, Australia, Benelux, Canada, Chili, China, Colombia, Costa Rica, Denmark, Eire, Finland, France, Great Britain, Greece, Holland, Hong Kong, Iceland, India, Iran, Israel, Italy, Japan, Korea, Lebanon, Malaysia, Mexico, Morocco, New Zealand, Norway, Pakistan, Peru, Philippines, Puerto Rico, Portugal, Scandinavia, South Africa, Spain, Switzerland, Thailand, Turkey, United States, Venezuela.

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SECTION 1
INTRODUCTION

MODEL 5000 LIQUID CHROMATOGRAPH

The Model 5000 contains within a single microprocessor-controlled unit all the components of a high-performance liquid chromatograph, at the same time providing the flexibility for adding optional automatic-sampling and data-handling accessories. The Model 5000 comprises three solvent reservoirs, gradient-forming components, a solvent-delivery system, a sample injector, a column enclosure that can accommodate four analytical or preparative columns and column heaters, and an electronics cabinet housing a control keyboard and a CRT.

A pair of microprocessor-controlled proportioning valves (a third is optional) admit solvent in an accurately metered ratio to the pump. The processor-controlled, single-piston, reciprocating pump then delivers the solvent mixture to the column, via a flow controller, mixing chamber, pulse damper, and pressure transducer. The available injectors are a stop-flow injector, a manual loop injector, and an automatic loop injector.

The keyboard allows the user to control completely the operating conditions of the instrument. The keyboard includes keys to select solvent reservoirs, flow rates, and solvent composition, thus allowing the user to construct operating programs in which each of these variables changes. As many as nine such programs can be stored in the instrument memory, and if desired, run consecutively without additional automated accessories. The CRT displays the status of all instrument parameters and shows a complete listing of the current program.

SPECIFICATIONS

GENERAL

Power requirements: 90-132 Vac or 180-265 Vac, 50 or 60 Hz (voltage and frequency specified on the tag attached to the power cord), 1000 W.

Temperature requirements: ambient temperature range 10 to 40°C (50 to 104°F).

Dimensions: 78.7 cm (31") wide x 50.8 cm (20") high x 50.8 cm (20") deep.

Weight: 68.1 kg (150 lb).

Operating pressure: 350 atm (5140 psi) maximum.

Column-temperature control: temperature controller is provided as an optional accessory; temperature is displayed in increments of 1°C, 140°C maximum; (control stability ±.25°C.

INJECTORS

Stop-Flow Injector

Maximum pressure: 350 atm (5140 psi).

Injection volume: 1-20 µl.

Manual Loop Injector and Automatic Loop Injector

Maximum pressure: 350 atm (5140 psi).

Injection volume: standard loop volume is 10 µl. Larger loop volumes are available and smaller injections are possible by using the optional syringe and adapter.

HYDRAULICS

Solvent Storage and Proportioning

Description: the reservoir compartment can accomodate three one-gallon solvent bottles; proportioning valves allow any two of the three reservoirs to be selected during gradient-elution programs; gradient formation on the low-pressure side of the pump.

Proportioning accuracy: % B accuracy = ±0.5% asbolute.

Pump

Description: single-piston, reciprocating pump driven by stepper motor.

Flow rate: linearly variable during operating programs, displayed in increments of 0.1 ml/min.

Maximum flow rate: 10 ml/min at 350 atm (5140 psi), 15 ml/min at less than 200 atm (3000 psi).

Flow rate accuracy: ±3% at less than (3500 psi). Retention times are reproducible to within 1%.

Purge rate: 10 ml/min.

Flow Controller

Description: provides constant backpressure against which solvent must be pumped, adjustable to 340 atm (5000 psi); set at factory to 238 atm (3500 psi).

Pressure Transducer

Description: a strain-sensitive semiconductor whose resistance varies with applied pressure. Pressure displayed in increments of 1 atm.

Overpressure protection: pump shuts off if pressure exceeds limit specified by user—350 atm (5140 psi) maximum.

STANDARD ACCESSORY KIT COMPONENTS

Following is a list of the contents of the Accessory package included in the shipping carton.

Check the contents of the package to ensure that all components listed have been received.

Report missing or damaged parts to:

Varian Instrument Divison
Aerograph Operations
2700 Mitchell Drive
Walnut Creek, CA 94598

3 ea	15-001410-00	Nut, Zero Dead Volume, 1/16", SS
1 ea	87-201026-00	Book, Basic Liquid Chromatography
1 ea	03-913807-00	Operator Manual, Model 5000
1 ea	03-905646-00	Kit, Variable Terminator
1 ea	03-905662-00	Kit, Repair, Inlet Valve
1 ea	03-905648-00	Kit, Tool, Model 5000
1 ea	03-905643-00	Kit, Repair, Piston Seal
1 ea	03-905645-00	Kit, Repair, Pressure Regulator
1 ea	03-912151-00	Assy, Column, MicroPak, 30 cm
2 ea	03-905638-00	Assy, Reservoir Cap
1 ea	02-001954-00	Assy, Cable, Signal Output
1 ea	03-905647-00	Seal, Inlet Port Plug
6 ft	24-000490-00	Tubing, TFE, 1/8 OD x .085 ID
2 ea	03-905326-00	Filter, 10 Microns
3 ea	16-000438-00	Ferrule, TFE, 1/16" Tube

2 ea	16-000437-00	Ferrule, 1/16", SS
1 ea	37-000654-00	Tubing, 1/16 OD x .009 ID, SS 316
1 btl	88-799450-00	Oil, Lubricating
3 ea	03-905341-00	Seal, Proportioning Valve
3 ea	27-402105-00	O-ring, TFE, .176 ID x .070 Width
1 ea	03-905640-00	Assy, Priming Pump
1 ea	67-132415-00	Fuse, 1½ A, 3 AG
1 ea	19-000029-00	Fuse, 8 A, 3 AG
1 ea	67-133440-00	Fuse, 4 A, 3 AG
1 ea	19-000015-00	Fuse 1 A, 3 AG, Slow Blow
1 ea	19-000018-00	Fuse, 20 A, 3 AG
1 ea	19-000013-00	Fuse, 3/8 A, 3 AG, Slow Blow
1 ea	67-129006-00	Fuse, 3 A, 3 AG, Slow Blow
1 ea	19-000046-00	Fuse, 6 A, 3 AG
1 ea	82-000291-00	Standard Sample

A NOTE ON THE MANUAL

For most chromatographers the most useful part of the manual will be Section 4, which explains in detail the CRT display and the keyboard (providing practical examples by way of illustration), and outlines the operating procedures for the instrument. All users should read Section 4 thoroughly before operating the Model 5000, then continue to use it as a guide when programming the instrument the first few times.

Section 2 provides installation instructions for the Model 5000, hence will be most useful to users whose instrument is not installed by Varian service personnel. All users should, however, read the first paragraph of Section 2 as a guide to the paragraphs that are more generally useful—for example, those covering injection and column installation.

Section 3 includes a brief description of the hydraulic components of the instrument and a discussion of the software.

Finally, Section 5 is devoted mainly to nonroutine maintenance and service procedures, and to a trouble-shooting guide, but paragraph 5.2 describes a routine lubrication procedure that ***must*** be performed monthly by all users.

SECTION 2
INSTALLATION

2.1 GENERAL

This section describes the procedures and requirements common to all Model 5000 installations, as well as the installation of several optional accessories. Much of what follows, therefore, is relevant only to customers whose instruments are ***not*** installed by Varian service personnel. However, this section also provides descriptive information that may be useful to all customers, including:

- solvent-line installation and replacement of the 10-μ solvent filters (paragraph 2.3.2)
- fuse descriptions (paragraph 2.5)
- description of the rear-panel outlets and electrical connections (paragraphs 2.6, 2.7, and 2.10)
- injector installation (paragraph 2.8)—it is sometimes necessary to change the position of the injector when changing the number or type of columns being used
- column installation (paragraph 2.9.2)
- description of available column and detector configurations (paragraph 2.9.1)
- installation and adjustment of the backpressure restrictor (paragraph 2.11)

The information least likely to be useful to the average chromatographer is printed in smaller type.

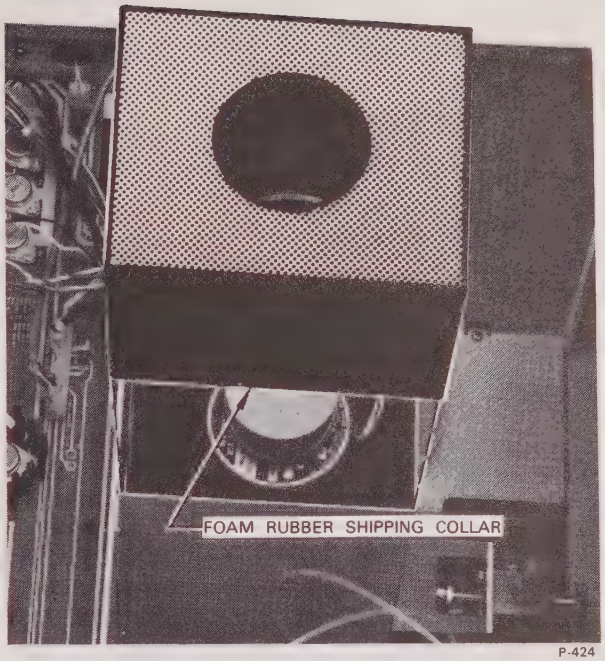
2.2 UNPACKING AND SITE PREPARATION

The preinstallation manual (Publication No. 03-913810-00) that was shipped ahead of your instrument covers unpacking the Model 5000 and describes the requirements for the site where it will be used. In addition, however, the shipping collar must be removed from the pump motor after the instrument is in place.

WARNING

SHOCK HAZARD

High voltages are exposed in the following procedure. The shipping collar should be removed *before* the instrument is plugged in.



P-424

FIGURE 2-1 REMOVING THE SHIPPING COLLAR

Remove the top cover from the main cabinet by removing the two screws inside the cabinet door, then lifting the front edge of the cover while sliding it toward the front of the instrument. Lift the shipping collar from inside the pump shroud as shown in Figure 2-1. Replace the top cover.

2.3 INSTRUMENT PREPARATION

Before the instrument is ready for use, two additional steps must be taken. The RAM battery, which provides power to the random-access memory, must be connected; and the solvent inlet lines must be connected to the proportioning valves. Both of these procedures are described below. If in addition it is necessary to install a column or to install and plumb an injector, refer to paragraphs 2.8 and 2.9.

2.3.1 Connecting the RAM Battery

The RAM battery will begin to discharge as soon as the following procedure is completed. Consequently there should be as little delay as possible between hooking up the battery and connecting the instrument to line power (paragraph 2.4)—the battery has a life of about 10 hours. Also, whenever the instrument is unplugged for more than about eight hours, the battery should be disconnected (by reversing the procedure below) so that it does not discharge completely. ***Line power will keep the battery charged, thus preserving memory, even when the instrument is turned off.***

WARNING

SHOCK HAZARD

The RAM battery must be connected *before* the instrument is connected to line power.

(1) Remove the top-and-side panel from the electronics cabinet by removing two screws: one to the upper right of the CRT screen and a second ***behind*** the UV Detector Controller front panel (or the blank panel if no UV Detector is installed)—see Figure 2-2. After removing the screws, gently push the top-and-side panel to the rear, then lift it from the instrument.

(2) Before proceeding, check that all printed-circuit boards are seated firmly in the electronics rack. Shipping can cause the boards to loosen in their slots.

FIGURE 2-2 REMOVING THE TOP-AND-SIDE PANEL FROM THE ELECTRONICS CABINET

(3) Figure 2-3 shows the two leads from the battery-charger printed-circuit board to the battery. In this illustration the perforated CRT cover has been removed, but it should not be necessary to remove the cover to connect the loose battery lead.

(4) Locate the loose (ground) lead; it should already be properly connected to the battery-charger PC board. Using a pair of small needle-nose pliers, connect the other end of the lead to the ***rear*** post of the battery, as shown in Figure 2-3.

(5) Replace the top-and-side panel of the electronics cabinet.

2.3.2 Installing the Solvent Lines

The lines that deliver solvent from the reservoirs to the proportioning valves must be installed as illustrated in Figure 2-4. For each line follow the procedure below, using components included in the standard accessory kit.

FIGURE 2-3 RAM BATTERY LEADS AND BATTERY-CHARGER PC BOARD

(1) Remove the stainless-steel compression nut (P/N 15-000632-00) and Teflon® ferrule (P/N 16-000441-00) from the base of the proportioning valve.

(2) Over the end of the solvent line ***above*** the reservoir cap, slip first the nut, then the Teflon ferrule, flat end first. The tapered end of the ferrule now faces the fitting on the proportioning valve.

(3) Insert the solvent line, as far as it will go, into the fitting at the base of the proportioning valve. Screw the compression nut onto the fitting, tightening it only finger-tight. Using one wrench on the hex nut at the base of the inlet-valve head and a second on the compression nut, tighten the compression nut an additional 1/4-turn. ***Overtightening this nut can constrict the solvent line.***

(4) Remove the compression nut and Teflon ferrule from the 10-μ filter assembly (P/N 03-905326-00), then slide them over the free end of the solvent line.

(5) Insert the solvent line into the body of the filter. The end of the line should extend only slightly into the filter, as shown in the inset of Figure 2-4. ***Again, tighten the nut only 1/4-turn past finger-tight.***

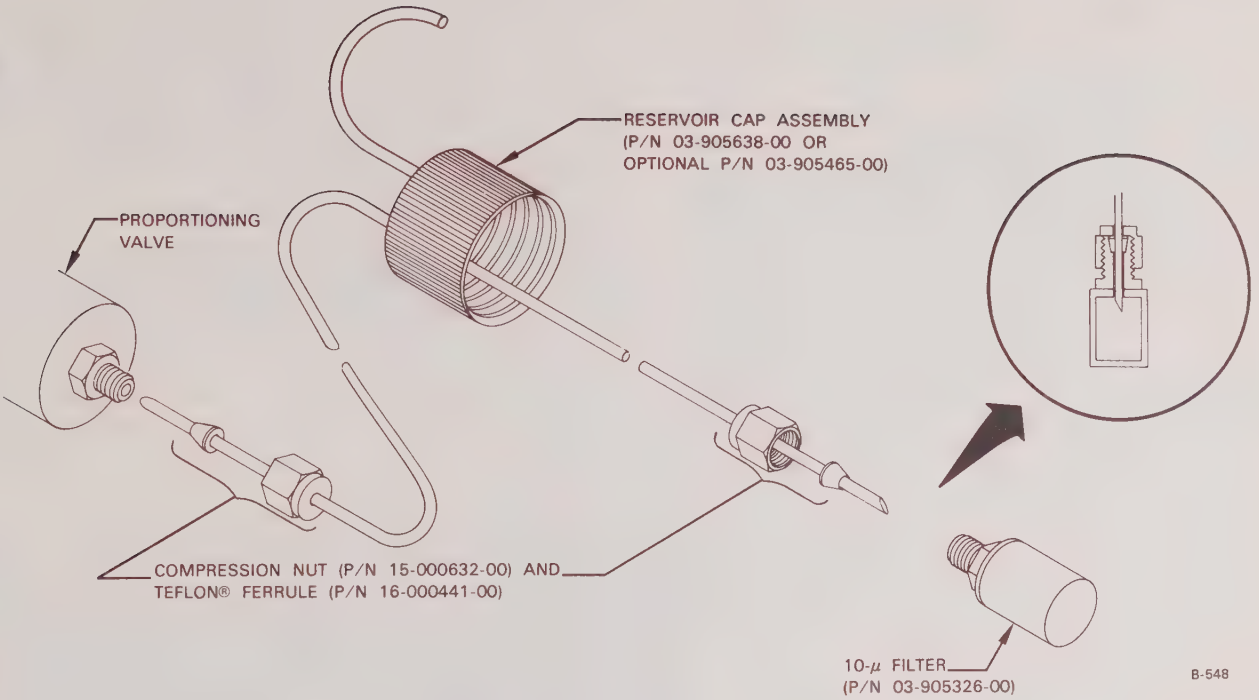


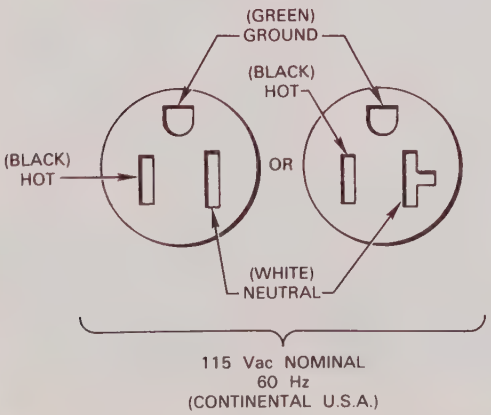
FIGURE 2-4 INSTALLING SOLVENT INLET LINES AND 10-μ FILTER

2.4 POWER REQUIREMENTS

Each Model 5000 has been wired at the factory for operation at the voltage and line frequency specified on the tag attached to the power cord. The instrument requires a single-phase power source capable of delivering 1000 W at the indicated ac voltage (±10%) and line frequency (50 or 60 Hz). The power cord is provided with a 3-prong plug compatible with the receptacles shown in Figure 2.5. If it is necessary to change this plug, you must comply strictly with the color coding shown in Figure 2-6.

If the prevailing line voltage in the area where the instrument is being used differs from that specified on the tag, the operating voltage of the instrument can be changed by rewiring the voltage-selection terminal strip inside the rear panel. This terminal strip, as well as its location in the instrument, is shown in Figure 2-7. Instruments operating in the low voltage range (90-132 Vac) can be wired for 100, 110, or 120 Vac; those operating in the high range (180-265 Vac) can be wired for 200, 220, or 240 Vac. You should not attempt to rewire the Model 5000 for operation in a different ***range*** from that for which it was prepared at the factory,

NOTE: POTENTIAL BETWEEN NEUTRAL AND GROUND SHOULD NOT EXCEED 3 VOLTS.



(1) POWER-LINE PLUGS AND RECEPTACLES FOR 230 Vac OPERATION HAVE NOT BEEN STANDARDIZED; THEREFORE NO MATING-HARDWARE RECOMMENDATIONS CAN BE MADE.

(2) REPLACEMENT OF INSTRUMENT POWER PLUG REQUIRES STRICT COMPLIANCE WITH POWER CORD COLOR CODING.

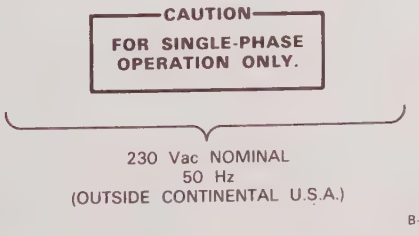


FIGURE 2-5 POWER REQUIREMENTS

NOTE: POTENTIAL BETWEEN NEUTRAL AND GROUND SHOULD NOT EXCEED 3 VOLTS.

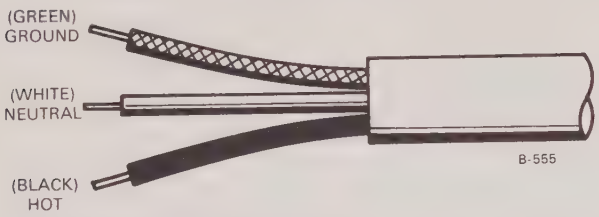


FIGURE 2-6 POWER-CORD COLOR CODING

nor for operation at a different frequency from that specified. To change the operating voltage ***within*** the high or low range, first determine precisely the local line voltage, then proceed as follows:

(1) Disconnect the instrument from all power.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be disconnected from line power.

(2) Remove the main rear panel (10 screws).

(3) Rewire the terminal strip shown in Figure 2-7 by moving only the violet (VIO) and orange (ORN) wires to the pair of leads that most nearly correspond to the local line voltage. Be sure to move both wires to corresponding terminals and to preserve the proper polarity.

(4) Replace the rear panel.

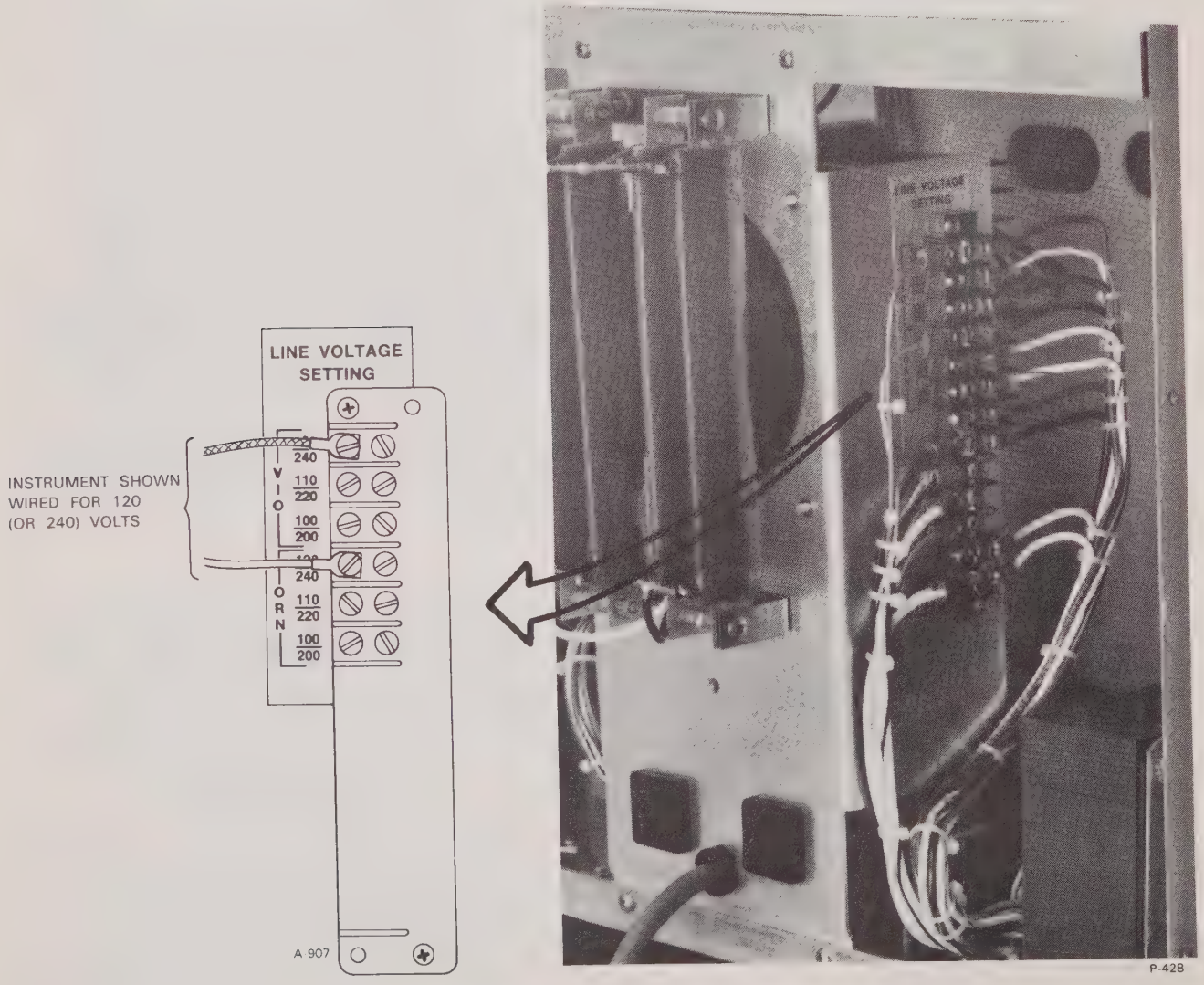


FIGURE 2-7 VOLTAGE SELECTION

2.5 CIRCUIT PROTECTION

The Model 5000 is protected by 12 fuses: F1-F4 are inside the flip-down panel on the front of the instrument, below the cabinet door; F5-F10 are on the main fuse panel inside the main rear panel of the instrument; F11 is on the power-control printed-circuit board inside the top cover of the main cabinet; and F12 is on the battery-charger board in the electronics cabinet (Figure 2-3). Access to the battery-charger board is described in paragraph 2.3.1. The ratings of the 12 fuses, as well as descriptions of the circuits they protect, appear in Table 2-1. Note that the ratings of fuses F1 through F4 depend on the line voltage.

WARNING

SHOCK HAZARD

To reach F5-F12 you must remove instrument panels. Before any panels are removed the instrument *must* be disconnected from line power.

2.6 REAR-PANEL OUTLETS

2.6.1 Accessory Outlets

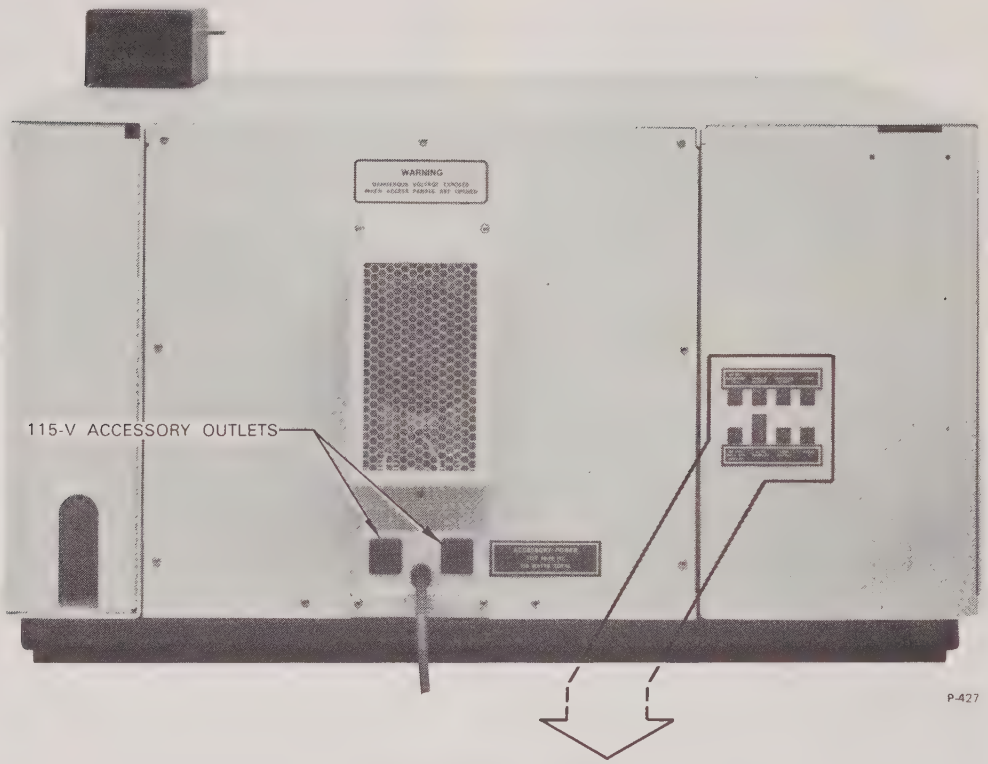
As shown in Figure 2-8 the Model 5000 provides two accessory outlets for peripheral equipment. Each supplies switched 115-Vac power, and they are rated at a maximum of 150 W (total). Note that if the optional external events 3 and 4 are installed, the ratings of these convenience outlets may decrease. ***The total rating of the two outlets, plus external events 3 and 4, is 150 W.***

2.6.2 External Events Connections

As described in more detail in Section 4, the operating programs run on the Model 5000 will, at the operator's option, activate any of four ***external events*** during the program. Events 1 and 2 provide contact closures between the pins of the respective plugs on the signal-outlet panel shown in Figure 2-8. Connections can be made using standard detector signal cables (P/N 02-001954-00). Events 3 and 4 are provided only as an optional accessory and, when activated by an operating program, supply 115-V power.

TABLE 2-1
FUSES

Fuse and Rating	Circuit Protected	Result of Failure
F1 8 A (110 Vac) 4 A (220 Vac)	Main Power	Complete shutdown
F2 6 A (110 Vac) 3 A, slow blow (220 Vac)	Transformer Primary	Complete shutdown (except battery continues to charge)
F3 3 A, slow blow (110 Vac) 1½ A (220 Vac)	Optional column heater	Inoperative column heater
F4 1½ A	Optional external events 3 and 4	Inoperative events 3 and 4, and inoperative column heater
F5 1 A, slow blow **F6** 1 A, slow blow	15-V analog circuitry	Erratic pressure and temperature display—pressure should read 510 atm and temperature 0°C (replace **F5** and **F6** together)
F7 4 A	Microprocessor and CRT	Blank CRT, and erratic pump and proportioning valve operation
F8 8 A	Logic	Complete shutdown
F9 20 A	Pump and proportioning	Pump failure—CRT continues to read PUMP RUNNING
F10 3/8 A, slow blow	Microprocessor and CRT	Erratic CRT display and erratic system operation
F11 3 A, slow blow	Proportioning valves	Inoperative valves
F12 1 A, slow blow	RAM power supply	No power to RAM: discharged battery, memory loss
F13 3/8 A, slow blow	RAM power supply	Same as **F12**



SIGNAL-OUTLET PANEL

UV DET RECORDER. In instruments with a 254/280-nm UV Detector installed, this outlet supplies the 1-mV (full scale) output signal. It should be connected to a strip-chart recorder as described in paragraph 2.7.1.

ANALOG OUTPUT. This outlet provides a signal corresponding to the value of the selected program parameter ANALOG OUT. If FLOW is selected the signal range (0.0-1.0 mV) corresponds to a flow-rate range of 0.0-20.0 ml/min; for % it corresponds to a solvent-composition range of 0-100%; for P is corresponds to a column-head-pressure range of 0-400 atm. Details on selecting the ANALOG OUT parameters are discussed in Section 4.

PROGRAM START. Each time an operating program begins, this outlet provides a contact closure lasting 600 msec. The contact is rated for a resistive load to exceed ***none*** of the following: 250 Vac, 0.5 A, 10 W.

EVENT 1 and EVENT 2. These outlets provide contact closures when the respective events are activated by the operating program being run. Each contact is rated for a resistive load to exceed ***none*** of the following: 250 Vac, 0.5 A, 10 W.

UV DET DATA SYS. If a CDS 111L or other data processing system is used with the Model 5000 and if a 254/280-nm UV Detector is installed, this plug provides the detector signal to the data system. The output specifications for this plug are discussed in the UV Detector manual (Publication No. 03-913809-00).

AUTOSAMPLER. This outlet is used as described in paragraph 2.7 if a Model 8050 AutoSampler is used. It sends a signal to the AutoSampler when a program is complete; the AutoSampler in turn either makes another injection and orders the LC to restart the program, or if no samples remain stops the pump.

TEMP OUTPUT. In instruments with the temperature-controller option installed, this outlet provides an output signal proportional to the temperature of the column. The signal range (0.0-1.0 mV) corresponds to a temperature range of 0-200°C.

FIGURE 2-8 MODEL 5000 REAR PANEL

The two accessory outlets on the rear panel, plus these optional external events, are rated at a maximum of 150 W (total). The connections for events 3 and 4 are made on a labeled terminal strip inside the rear panel, as shown in Figure 2-9.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed when the rear panel is removed. Before you remove the panel, the instrument *must* be disconnected from line power.

To use these powered, external-event outputs, remove the main rear panel (10 screws), then make connections to the terminal screws indicated on the label. Note the position of the grounding lug in Figure 2-9. The cables used with these external events should be rated at 150 W or more.

2.6.3 Signal-Outlet Panel

The eight outlets of the signal-outlet panel (including external events 1 and 2) are described in Figure 2-8.

2.7 ELECTRICAL CONNECTIONS

The electrical connections depend on the peripheral equipment being used, as well as the options installed on your instrument. This paragraph describes the connections between the Model 5000 (with a 254/280-nm UV Detector installed) and a CDS 111C (or 111L) chromatography data system, a Model 8050

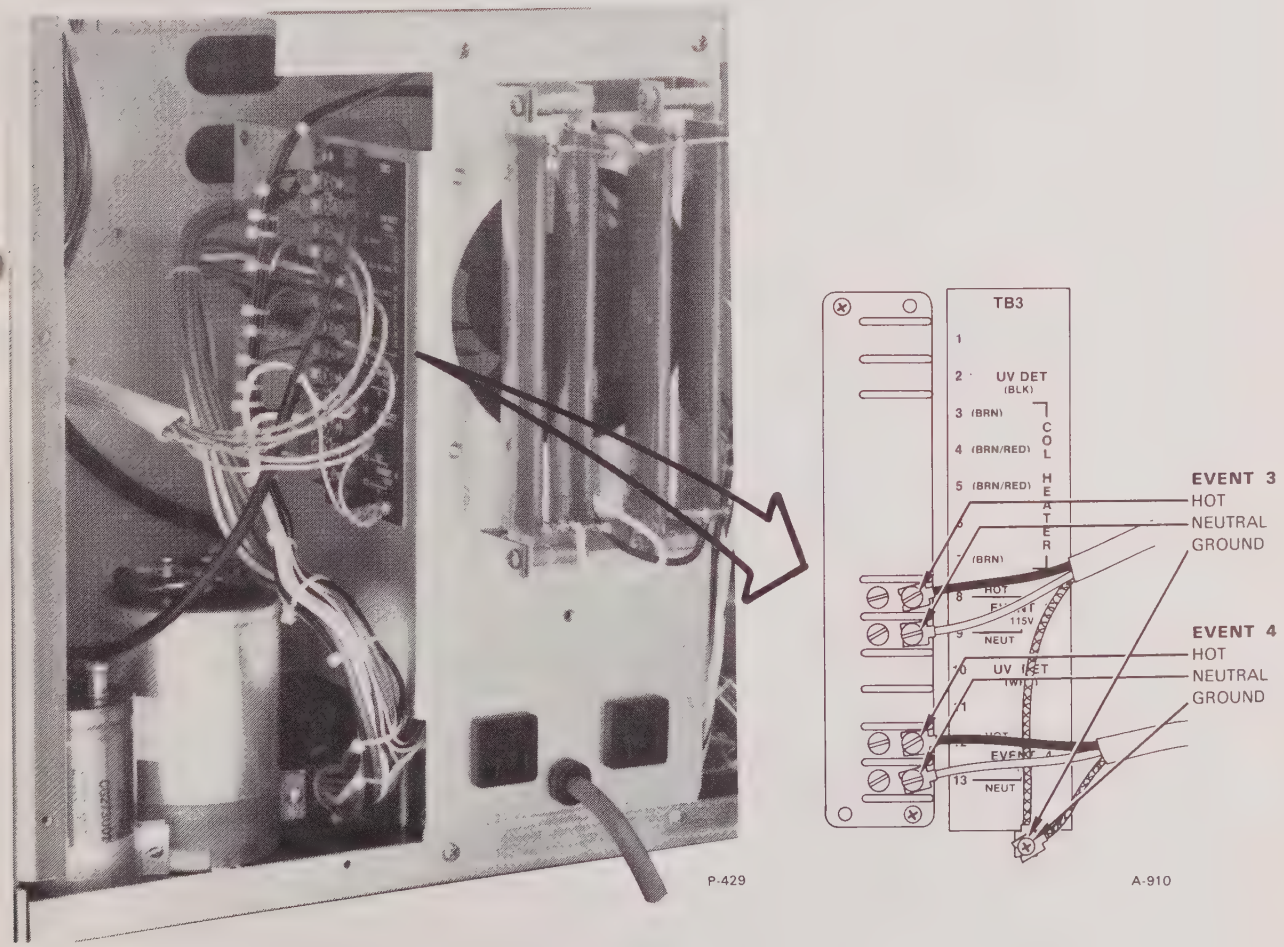


FIGURE 2-9 CONNECTIONS FOR EXTERNAL EVENTS 3 AND 4

AutoSampler, and a Model 9176 strip-chart recorder. It also describes the use of the other rear-panel signal outlets.

2.7.1 Connecting the Signal Outlets

The signal-outlet panel includes three 1-mV output plugs (TEMP OUTPUT, ANALOG OUTPUT, and UV DET RECORDER), and a fourth higher-voltage output plug (UV DET DATA SYS). The TEMP OUTPUT plug is functional only on instruments with the optional temperature controller, and the UV Detector outlets only on instruments with an inboard 254/280-nm UV Detector installed. Each of the 1-mV outlets can be connected to a strip-chart recorder with a standard detector signal cable (P/N 02-001954-00), as shown in Figure 2-10. The shield connector must not be grounded at the recorder. If a guard connection is not available at the recorder, the shield connector on the cable should be masked with electrical tape. If the UV DET DATA SYS outlet is being used, it must be connected to a CDS 111 (or other data system) with another detector signal cable. The shield should not be connected at the CDS 111.

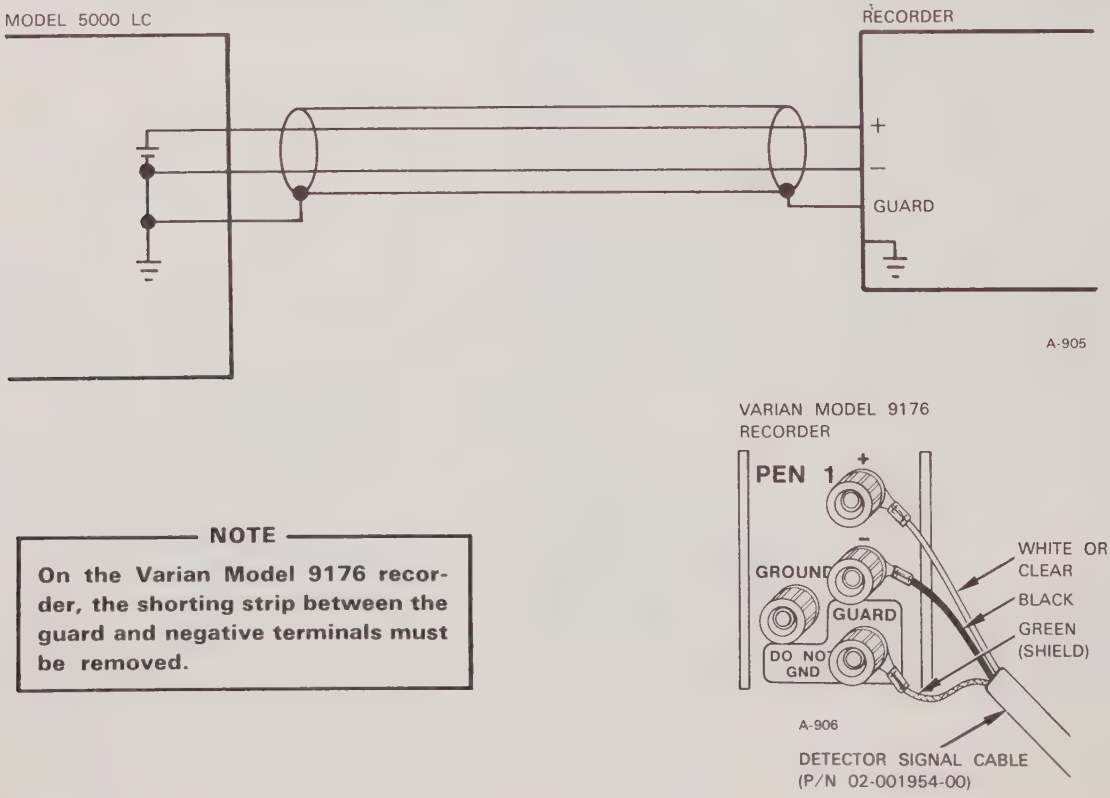
2.7.2 AutoSampler and CDS 111C (without Automation Option)

Figure 2-11a illustrates the connections between a Model 5000 LC (with a 254/280-nm UV Detector installed) and a Model 8050 AutoSampler; Figure 2-11b shows the connections among a Model 5000, a CDS 111C, and an AutoSampler. As explained in paragraph 4.4 these connections permit the Model 5000 to communicate with the AutoSampler either by activating event 1 or by sending it a PROGRAM COMPLETE signal. The UV DET DATA SYS outlet provides the detector signal to the CDS 111C.

If the CDS 111C is used alone, it must be operated manually, and it is connected to the Model 5000 only with the signal cable from the UV DET DATA SYS outlet.

2.7.3 AutoSampler and CDS 111L (with Automation Option)

Figure 2-12 illustrates the connections among a Model 5000 (with a 254/280-nm UV Detector installed), a Model 8050 AutoSampler, and a CDS 111L, when the Automation Interface option is installed in the Model 5000. This automation option

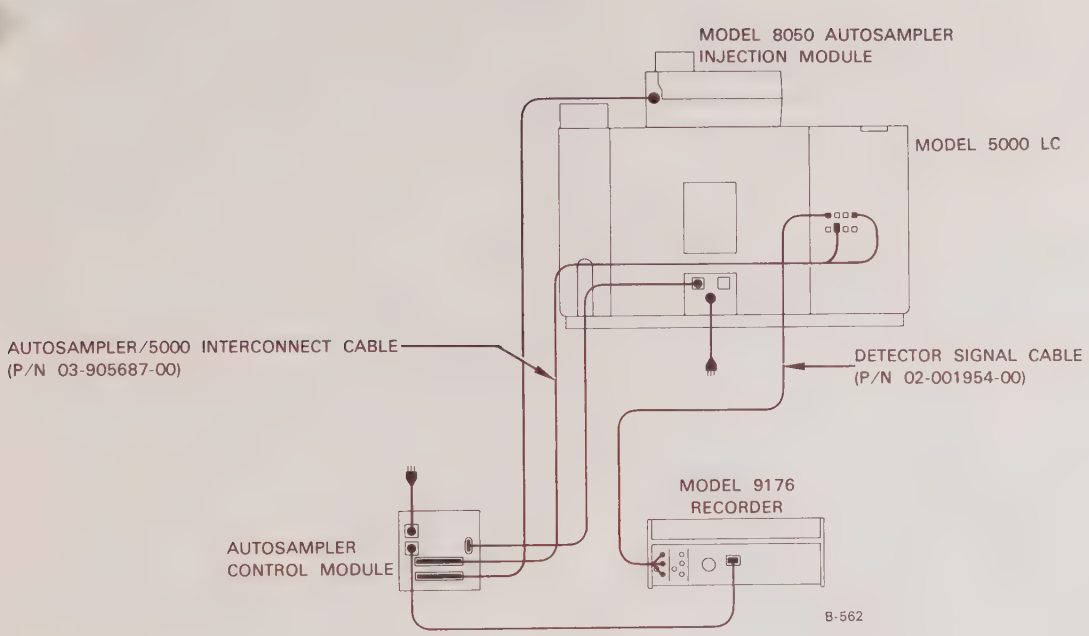


NOTE

On the Varian Model 9176 recorder, the shorting strip between the guard and negative terminals must be removed.

FIGURE 2-10 CONNECTING THE 1-mV SIGNAL OUTLETS TO A STRIP-CHART RECORDER

(a)



(b)

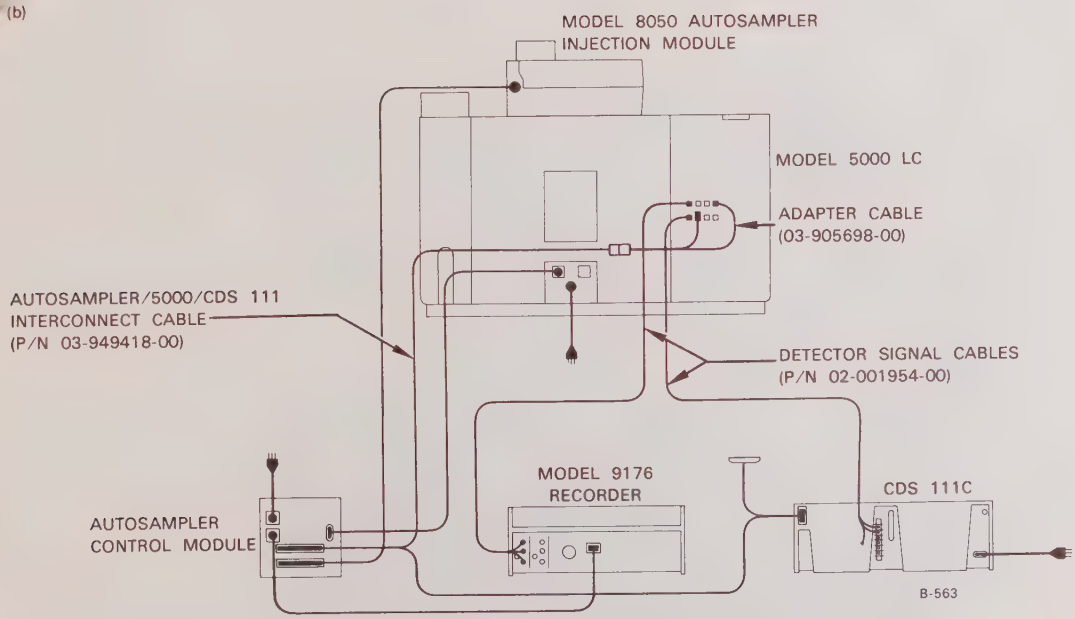
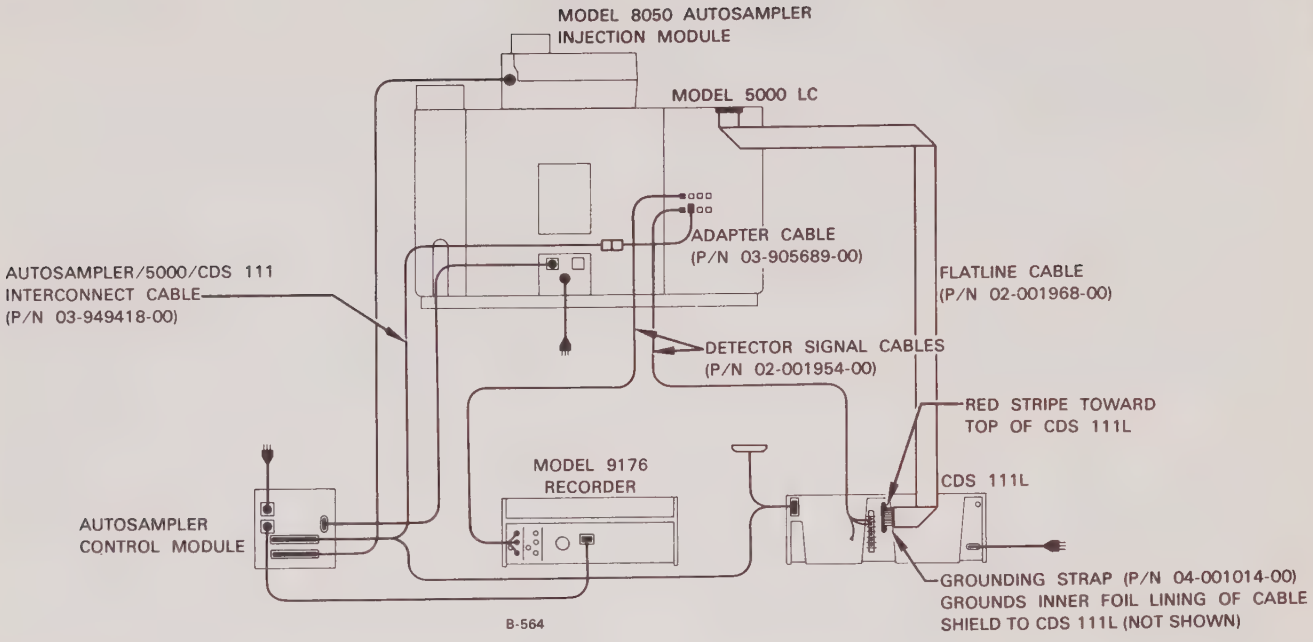


FIGURE 2-11 ELECTRICAL CONNECTIONS
(a) with AutoSampler, (b) with AutoSampler and CDS 111C

(a)



(b)

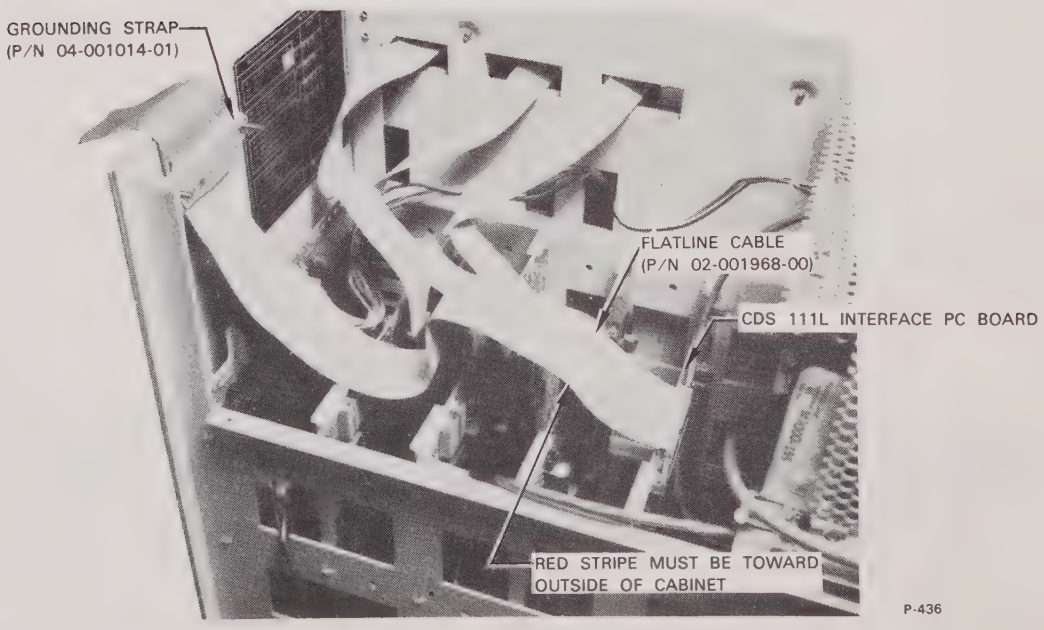


FIGURE 2-12 ELECTRICAL CONNECTIONS WITH AUTOMATION INTERFACE
(a) Schematic, (b) Installing the Flatline Cable at the Model 5000

includes a CDS 111L specially designed for LC applications and a CDS 111L interface printed-circuit board (in the Model 5000) that permits direct communication between the Model 5000 and the CDS 111L via the flatline cable. The option thus allows greater flexibility than the system illustrated in Figure 2-11b. Details on the operation of systems that include the CDS 111L appear in the CDS 111L Addendum to the CDS 111C Operators Manual (Publication No. 85-001142-00).

The flatline cable (P/N 02-001968-00) plugs into the rear of the CDS 111L as shown in Figure 2-12a. ***Take care to ensure that the red stripe on the edge of the cable is nearer the top of the CDS 111L,*** and use the grounding strap (P/N 04-001014-00—supplied with the cable) to ground the inner foil lining of the shield to the cabinet of the CDS 111L. To connect the cable to the Model 5000 proceed as follows:

(1) Disconnect the Model 5000 from all power.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be disconnected from line power.

(2) Remove the top-and-side panel from the electronics cabinet by removing the screw to the upper right of the CRT screen and the screw ***behind*** the UV Detector Controller front panel (or the blank panel if no UV Detector is installed)—see Figure 2-2. After removing the screws, gently push the top-and-side panel to the rear, then lift it from the instrument.

(3) Connect the flatline cable to the CDS 111L interface printed-circuit board as shown in Figure 2-12b, ***observing the orientation of the red stripe.***

(4) Fold back the cable shield to expose the foil lining, then fasten the cable to the frame of the Model 5000, again as shown in Figure 2-12b. The grounding strap shown in the figure provides strain relief and grounds the cable shield. Replace the top-and-side panel of the electronics cabinet.

2.8 INJECTOR INSTALLATION

2.8.1 Installing the Manual Loop Injector

The manual 6-port loop injector is one of the three injectors available for the Model 5000 LC. To mount the loop injector on the top of the column enclosure, refer to Figure 2-13. Most of the components shown in this figure will already be mounted on the instrument, but the injector body and the tubing associated with it must be installed. ***Be sure to mount the injector exactly as shown, with the cutout in the valve collar to the upper left;*** otherwise, the operating instructions in Section 4 will not be strictly applicable. When installing the tubing supplied with the injector, take care not be bend or kink the tubing. Seat the swaged ferrules securely in the valve ports, then tighten the compression nuts moderately. ***Do not overtighten the nuts.***

CAUTION

Use only fittings explicitly designed for use with the loop injector. Other fittings, however similar, can damage the injector ports.

The tubing that connects the loop injector to 3/8" gel permeation columns and 1/2" preparative columns must be cut to length according to the column configuration being used. Procedures for cutting and cleaning 0.009" ID stainless-steel tubing, as well as a discussion of the various column configurations, is included in paragraph 2.9.

2.8.2 Installing the Automatic Loop Injector

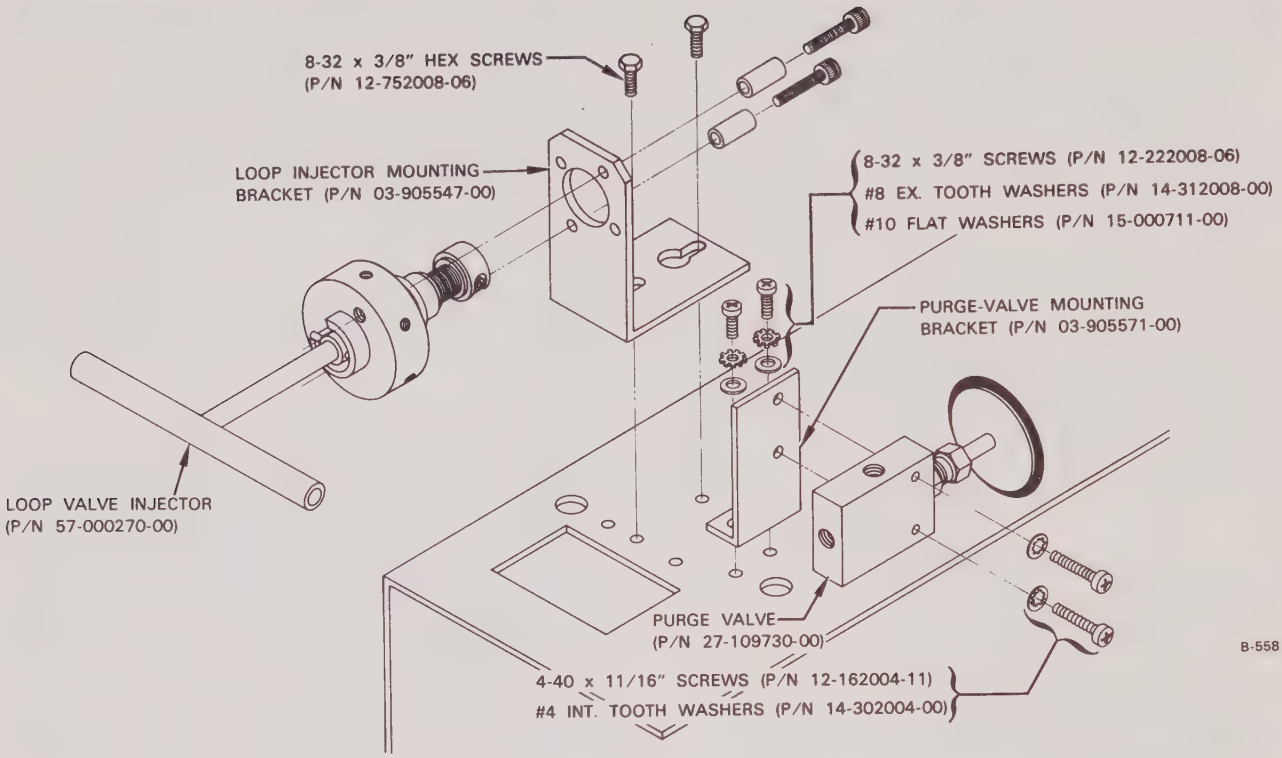
The automatic loop injector will be installed at the factory in all instruments ordered with this injector. It uses the same tubing and mounting hardware described in Figure 2-13. In addition a solenoid valve, which controls the injector actuator by supplying air to the two inlets on the actuator, is mounted on the rear wall of the column enclosure. The solenoid valve, in turn, is connected electrically to external event 3. (Paragraph 4.4.3 describes the general features of operating programs that use event 3 to actuate the automatic loop injector, and Example 3 in paragraph 4.2 provides an example.) When the Model 5000 is installed, the inlet port (marked IN) of the solenoid valve should be connected to a supply of compressed air. Forty to sixty psi gives good results with the automatic loop injector; the pressure must never exceed 100 psi.

2.8.3 Installing the Stop-Flow Injector

The stop-flow injector will already be installed in all instruments ordered with this injector. However, it may be necessary to remove and reinstall the injector as different combinations of columns are used. Paragraph 2.9.1 describes the various column configurations available, noting for each whether the stop-flow injector must be in the high or low position. As shown in Figure 2-14, the mounting bracket for the stop-flow injector determines the position of the injector: when the injector is mounted on the longer flange (as illustrated), it is in the high position; when it is on the shorter flange, it is in the low position. If it is necessary to reinstall the stainless-steel tubing supplied with the injector, make sure the swaged ferrules fit snugly in the injector body, then tighten the nuts moderately. ***Do not overtighten the nuts.*** Note also that the 1.35" piece of tubing (P/N 03-905591-00) that connects the injector to the column must be oriented so that the end with the tapered bore (which serves as a needle guide) is connected to the injector.

2.9 COLUMN AND HEATER-BLOCK INSTALLATION

The column enclosure of the Model 5000 was designed to accommodate as many as four analytical or



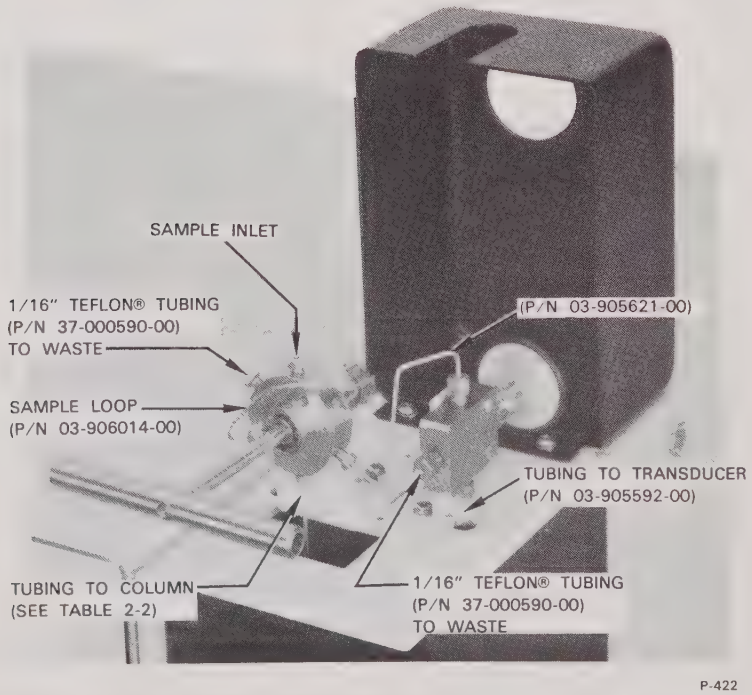
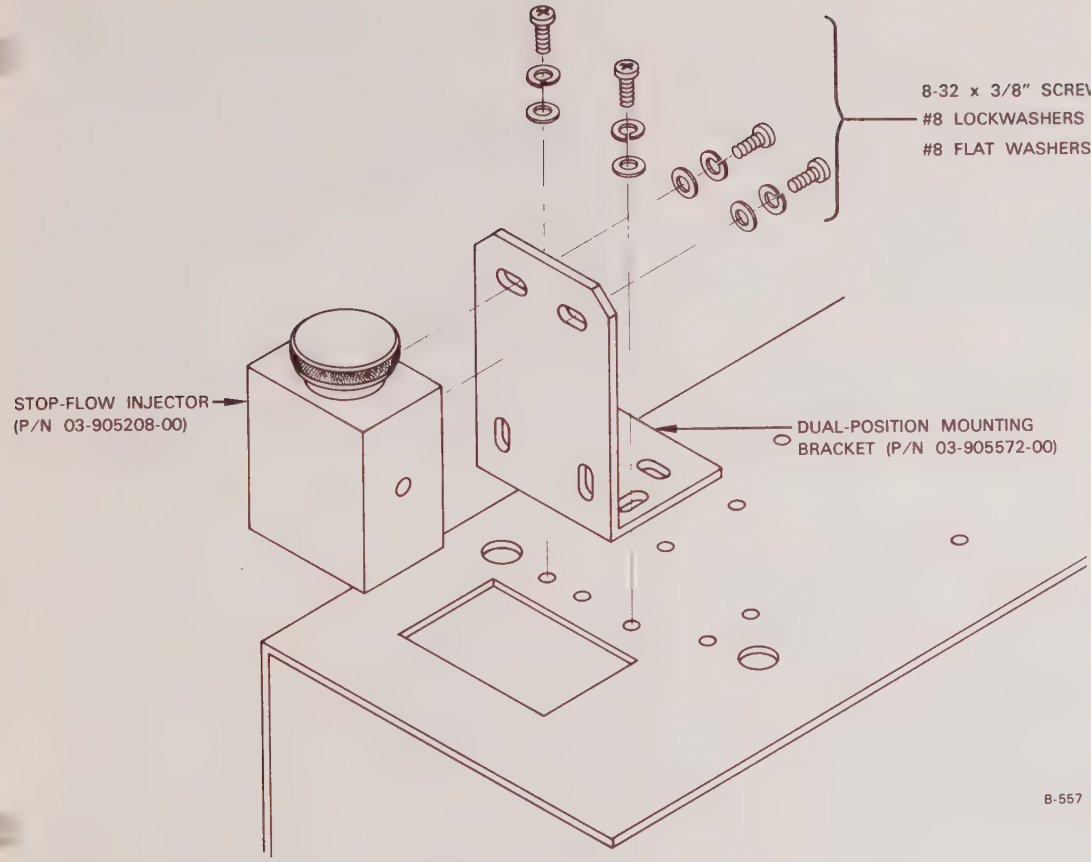


FIGURE 2-13 INSTALLING THE MANUAL LOOP INJECTOR



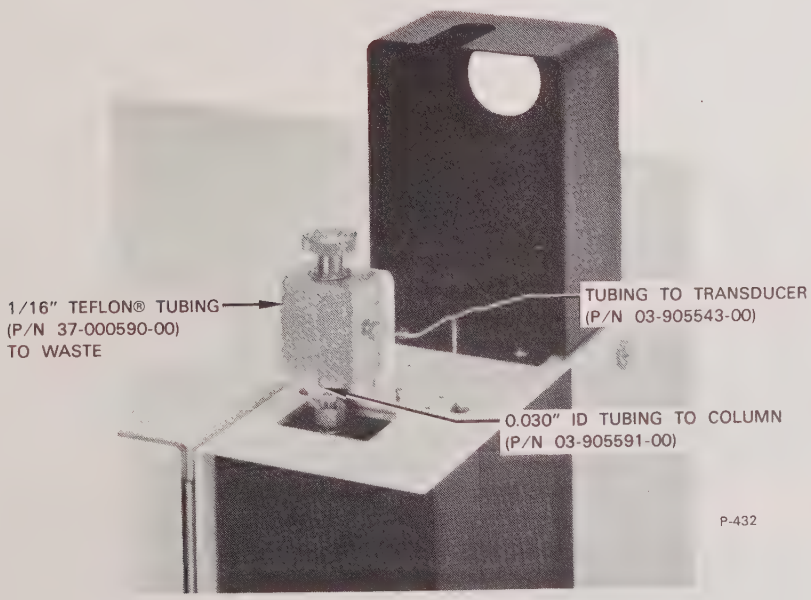


FIGURE 2-14 INSTALLING THE STOP-FLOW INJECTOR

preparative columns. To minimize the length of tubing between the column exit and the inlet of the detector, the Varian 254/280-nm UV Detector can therefore occupy any of six positions in the column enclosure, depending on the number and length of columns being used. This paragraph discusses and illustrates these configurations, and describes the installation of columns and column-heater blocks. For instruments without the temperature-controller option or the UV Detector, the principles governing column installation are the same as those outlined here.

2.9.1 Column and Detector Configurations

Figure 2-15 and Table 2-2 summarize the column and UV Detector configurations for which the Model 5000 was designed. Both of the drawings in Figure 2-15 show the 32 threaded holes that have been provided in the column enclosure for the various configurations; each detector and heater-block position uses a pair of holes, shown in the illustrations as screwheads. Note that in column positions 2, 3, and 4, either one or two heater blocks can be installed. Table 2-2 describes each of the available column configurations, noting the injector position (see paragraph 2.8.3), the heater-block position, and detector position required for each. (Figure 2-17, for example, shows the stop-flow injector in the low position, the column-heater block in position 2, and the detector in position 2.) The table also describes the plumbing for each configuration, some of which require that 0.009" ID stainless-steel tubing be cut to length.

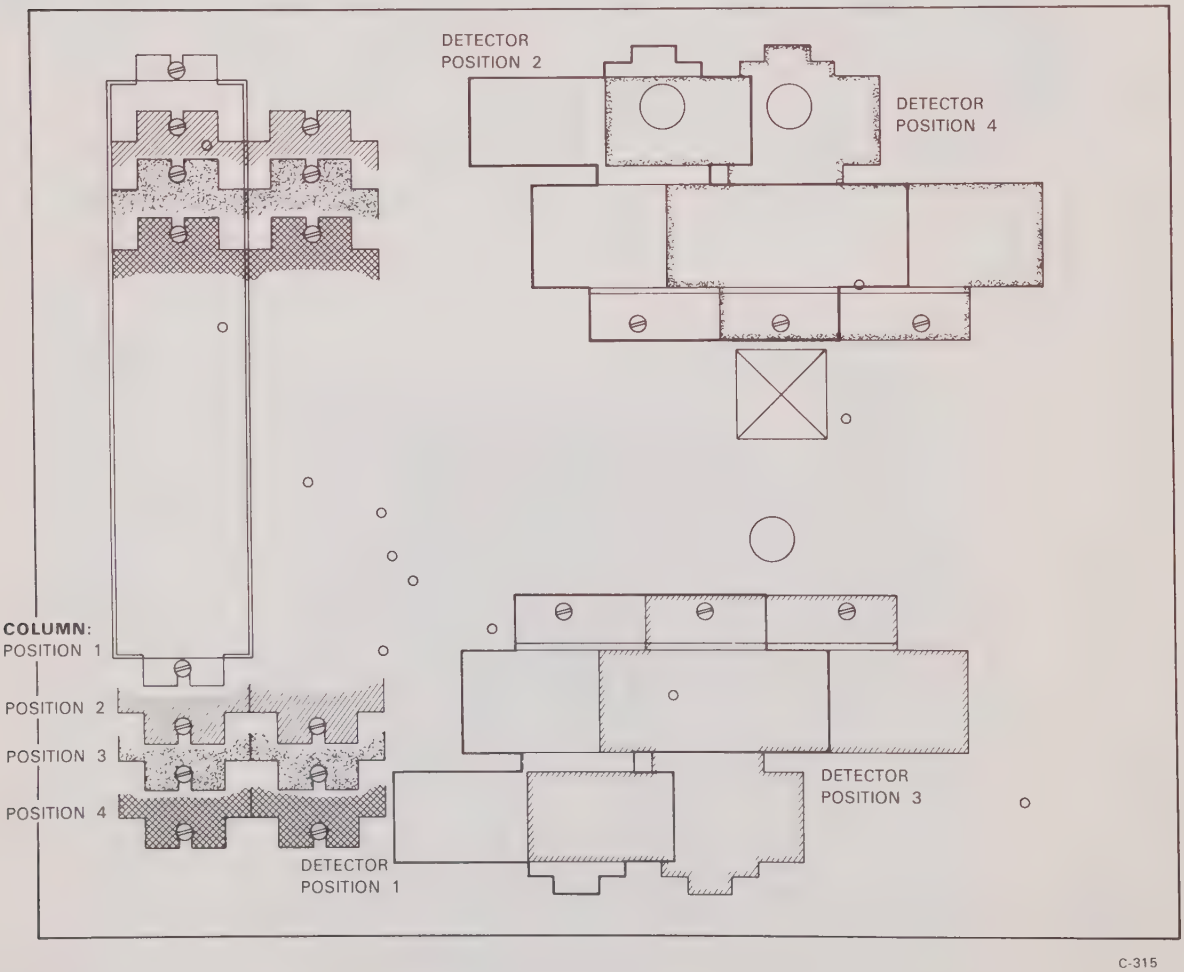


FIGURE 2-15 HEATER BLOCK AND UV DETECTOR POSITIONS
(a) 30-cm Columns

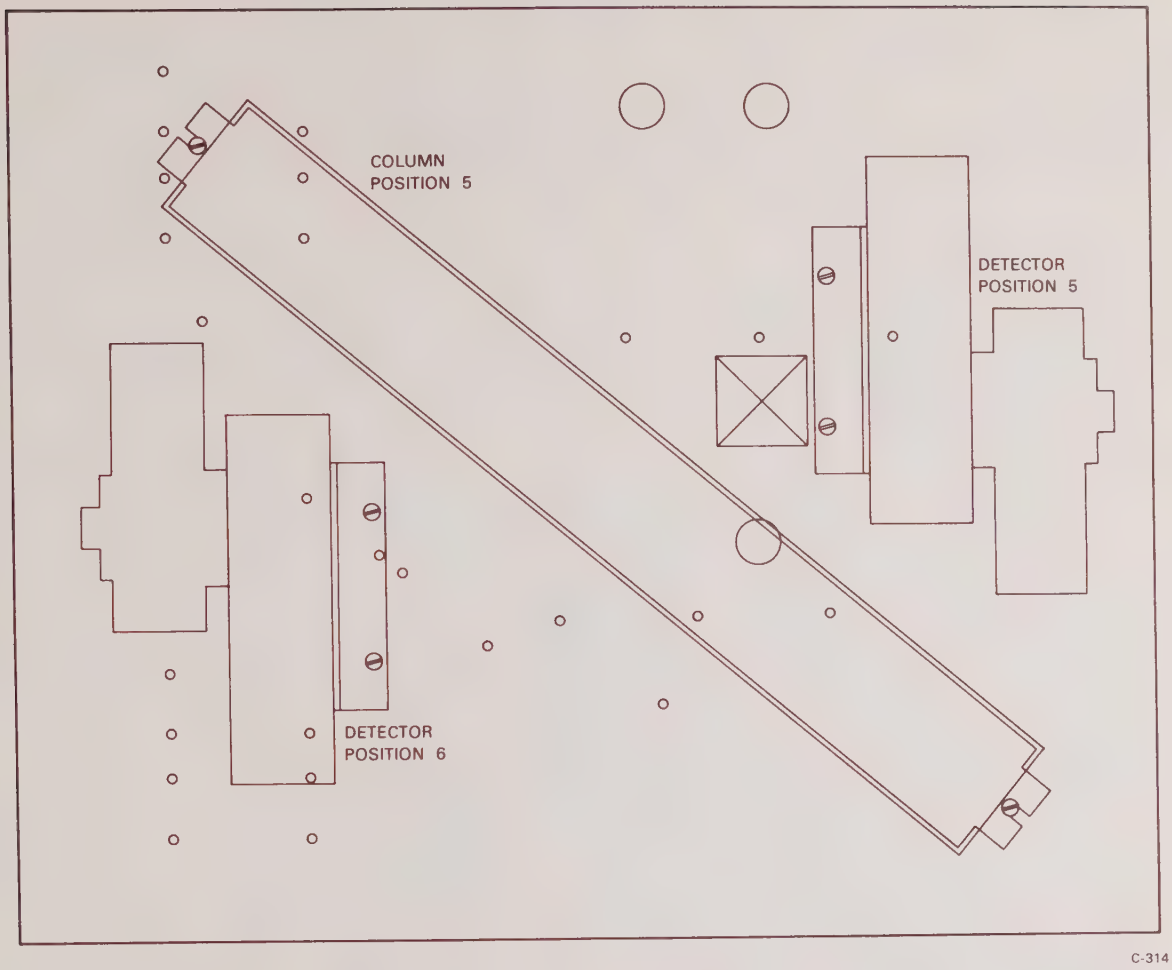


FIGURE 2-15 HEATER BLOCK AND UV DETECTOR POSITIONS (Cont.)
(b) 50-cm Columns

2.9.2 Installing a Column

Figure 2-16 illustrates the installation of a single 30-cm column into a heater block in the column enclosure of a Model 5000. The steps below refer to this figure but are typical of all column installations. If the column configuration demands additional tubing (see Table 2-2), use only 0.009" ID stainless-steel tubing (P/N 37-000654-00), zero-dead-volume unions (P/N 16-000222-00), and stainless-steel ferrules (P/N 16-000437-00). Cleaning and cutting procedures for stainless-steel tubing can be found in paragraph 2.9.6. The following steps pertain only to the installation of a column; injector installation was covered in paragraph 2.8, and the installation of the UV Detector is described in a separate manual (Publication No. 03-913809-00).

(1) With the instrument power switch turned off and the detector mounted in place, connect the column exit to the sample-cell inlet of the detector, using the compression fitting described in Figure 2-16.

(2) Place the column in the heater block as shown, taking care not to kink or twist the inlet tube of the detector. Connect the column to the tubing from the injector, again using the compression fitting described in the figure.

(3) Slide the column mounting bar into the heater block as shown in the inset and tighten the two thumbscrews finger-tight. Slip the heater-block cover (not shown) over the heater block.

TABLE 2-2
COLUMN, INJECTOR, AND UV DETECTOR CONFIGURATIONS

Column Position	Injector	Column Configuration	UV Detector Position	Remarks on Plumbing
1	Stop-flow (high position)	1—30 cm	1	Injector to column: tubing (P/N 03-905591-00) supplied with injector, tapered bore toward injector Column to detector: sample-inlet tube of detector
2	Stop-flow (low position)	2—30 cm 3—30 cm 4—30 cm	2 3 4	Injector to column: tubing (P/N 03-905591-00) supplied with injector, tapered bore toward injector Column to column (if necessary): 0.009" stainless-steel tubing (P/N 37-000654-00) must be cut to length and bent as required Column to detector: sample-inlet tube of detector
	Loop	1—30 cm (1/4" only) 2—30 cm (1/4" only) 3—30 cm (1/4" only) 4—30 cm (1/4" only)	1 2 3 4	Injector to column: tubing (P/N 03-905631-01) supplied with injector Column to column (if necessary): 0.009" stainless-steel tubing (P/N 37-000654-00) must be cut to length and bent as required Column to detector: sample-inlet tube of detector
3	Loop	1—30 cm (1/2" or 3/8") 2—30 cm (1/2" or 3/8") 3—30 cm (1/2" or 3/8") 4—30 cm (1/2" or 3/8")	1 2 3 4	Injector to column: 0.009" stainless-steel tubing (P/N 37-000654-00) must be cut to length Column to column (if necessary): 0.009" stainless-steel tubing (P/N 37-000654-00) must be cut to length and bent as required Column to detector: sample-inlet tube of detector
4	Stop-flow (high position) or Loop	Guard column + 1—30 cm Guard column + 2—30 cm Guard column + 3—30 cm Guard column + 4—30 cm	1 2 3 4	Loop injector to guard column: tubing (P/N 03-905631-00) supplied with guard column Stop-flow injector to guard column: tubing (P/N 03-905591-00) supplied with injector, tapered bore toward injector Guard column to column: tubing (P/N 03-905631-00) supplied with guard column Column to column (if necessary): 0.009" stainless-steel tubing (P/N 37-000654-00) must be cut to length and bent as required Column to detector: sample-inlet tube of detector
5	Loop	1—50 cm 2—50 cm	5 6	Same as column position 3

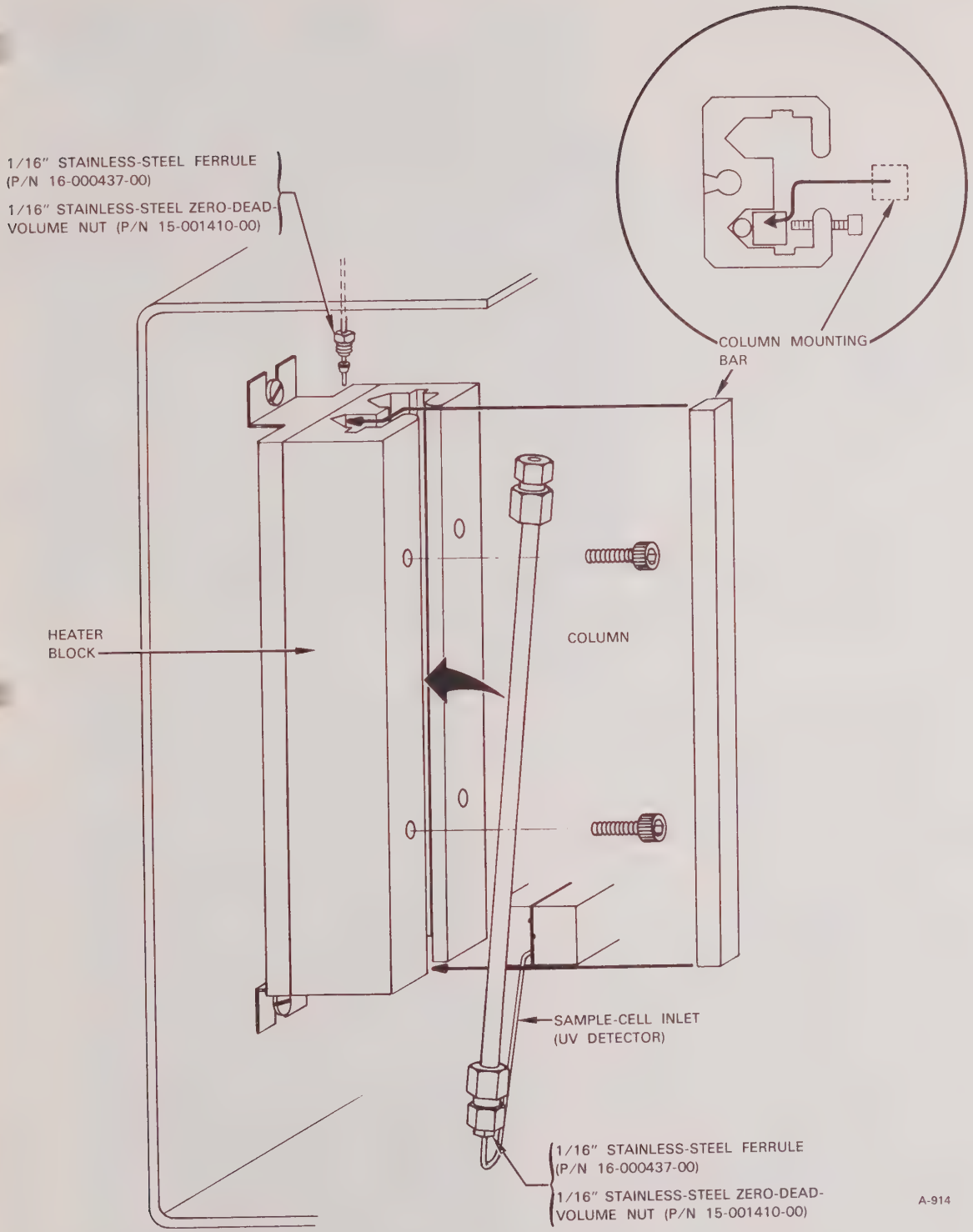


FIGURE 2-16 INSTALLING A COLUMN

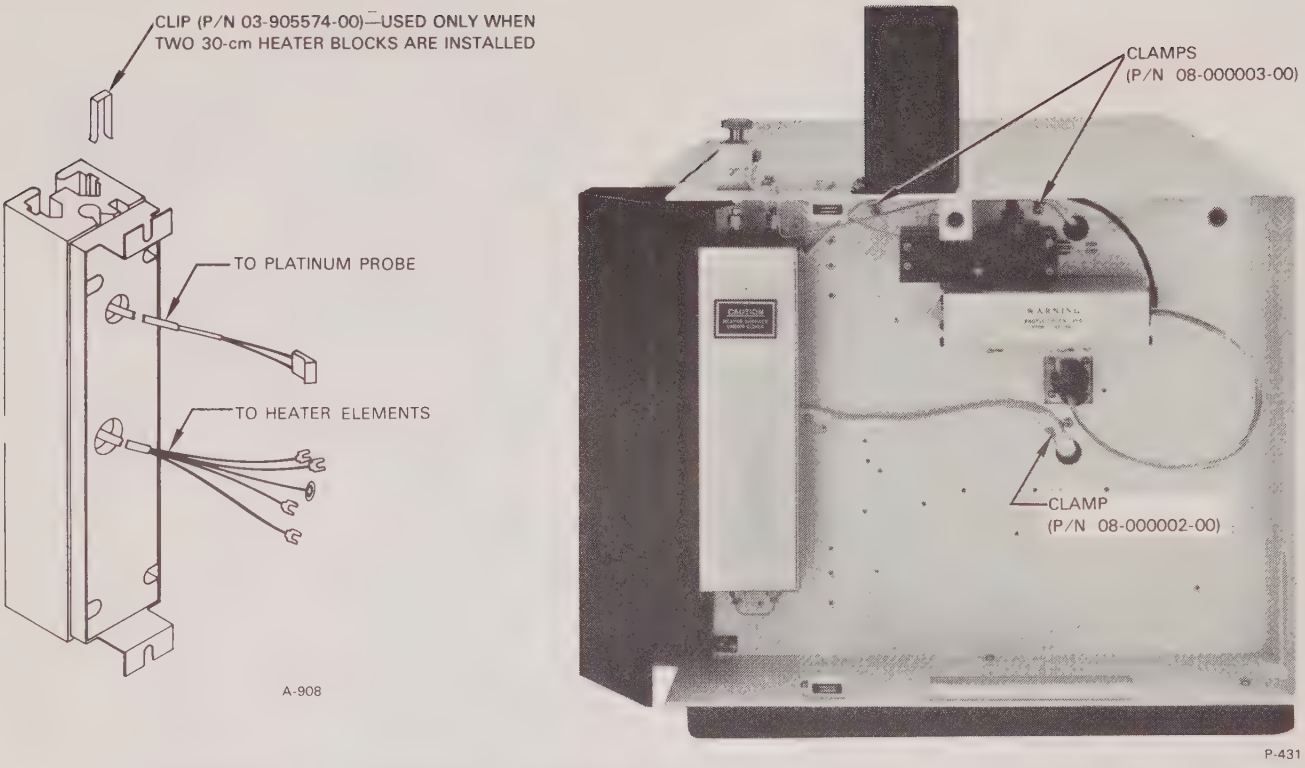


FIGURE 2-17 MOUNTING A HEATER BLOCK IN THE COLUMN ENCLOSURE

2.9.3 Mounting a Heater Block

The following steps, together with Figures 2-17 and 2-18, describe the procedure for installing or changing a heater block in an instrument with the temperature-controller option. The next paragraph (2.9.4) describes how to add a second block when one is already installed. Though the following procedure pertains to a single dual-column, 30-cm block, the same principles apply to other installations.

(1) Unplug the Model 5000 from line power.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be disconnected from all power.

(2) Each heater block contains a platinum probe, which senses the temperature of the block, and a pair of ceramic heater elements. Using two 3/16" screws (P/N 12-162008-03), mount the block in the column enclosure with the probe wires at the top, in the position demanded by the column configuration to be used (see Figure 2-15 and Table 2-2).

(3) Route the wires from the probe and the heater elements into the main cabinet of the Model 5000 and secure them in the column enclosure with the clamps provided, as shown in Figure 2-17.

(4) Remove the top cover of the instrument by removing the two screws inside the main cabinet door, then sliding the cover forward and lifting it from the instrument. Plug the connector on the platinum probe assembly into the receptacle on the power-control printed-circuit board, as shown in Figure 2-18a. Replace the cover.

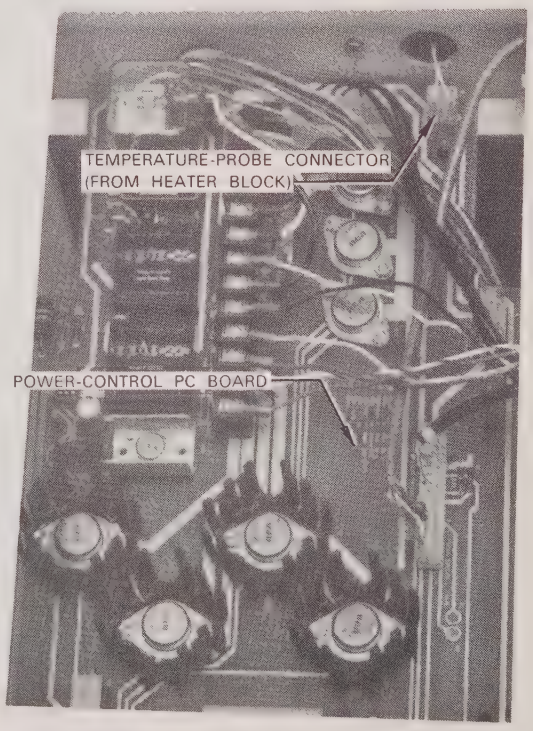


FIGURE 2-18 CONNECTIONS FOR COLUMN HEATERS (a) Temperature Probe

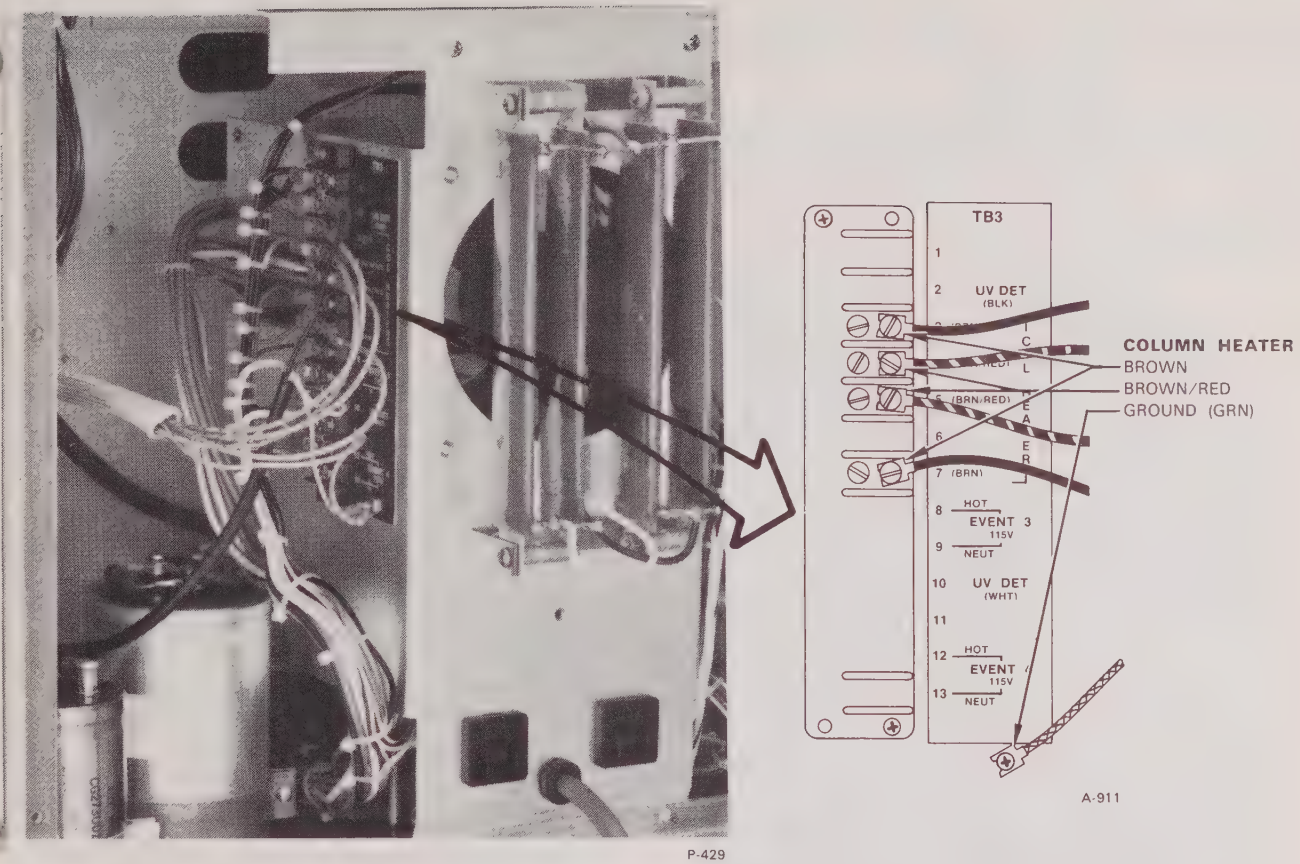


FIGURE 2-18 CONNECTIONS FOR COLUMN HEATERS (Cont.)
(b) Heater Elements

(5) Remove the rear panel of the instrument (10 screws). Connect the five wires from the heater elements as shown in Figure 2-18b. Attach the two brown and two brown/red wires to the labeled terminal strip, matching the color of the wire to the color indicated on the label, and attach the green wire to the grounding lug as shown. Replace the rear panel.

2.9.4 Adding a Second Heater Block

As shown in Figure 2-15a, the column enclosure of the Model 5000 can accommodate two dual-column, 30-cm heater blocks. In these configurations, only one of the blocks contains a platinum temperature probe, but both contain a pair of heater elements. Therefore, to install a second block in an instrument already containing one, only the heater-element wires must be connected as described in step (5) in paragraph 2.9.3 above. Connect the wires to the same terminals used for the first block, so that each terminal contains a pair of wires of the same color.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed when the rear panel is removed. The instrument *must* be disconnected from line power.

To ensure good thermal contact between the two blocks, install the two clips (P/N 03-905574-00) that are provided with the second block, as shown in Figure 2-17. (The second block is also accompanied by a heater-block cover that covers both blocks.)

2.9.5 Setting the Temperature-Limit Switch

The circuitry of the temperature controller limits the operating temperature of the column heaters to either 75°C (standard) or 150°C, depending on the position of the temperature-limit switch, which is located on the temperature-controller printed-circuit board. To change the position of this switch, proceed as follows:

(1) Disconnect the instrument from line power.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be disconnected from all power.

(2) Remove the top-and-side panel from the electronics cabinet by removing the screw to the upper right of the CRT screen and the screw ***behind*** the UV Detector Controller front panel (or the

blank panel if no UV Detector is installed)—see Figure 2-2. After removing the screws, gently push the top-and-side panel to the rear, then lift it from the instrument.

(3) Slide the two-position switch near the top edge of the temperature-controller printed-circuit board (Figure 2-19) to the position desired. Replace the top-and-side panel of the electronics cabinet.

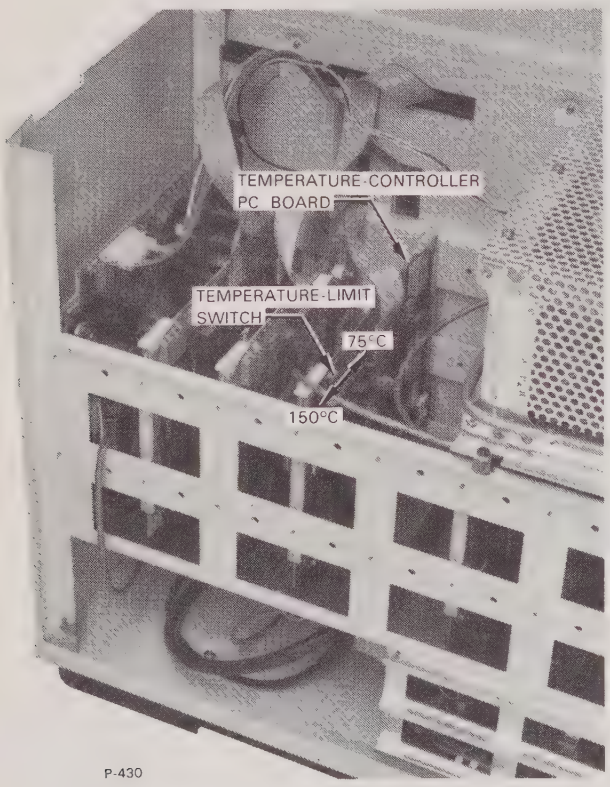


FIGURE 2-19 SETTING THE TEMPERATURE-LIMIT SWITCH

2.9.6 Cutting and Cleaning Stainless-Steel Tubing

If additional pieces of 0.009" ID tubing are needed for the column configuration being used (see Table 2-2), care should be taken that it is properly cut, deburred, and cleaned before it is installed in the instrument.

(1) Place the tubing on a clean, flat surface. Place a knife blade at the point to be cut, then while pressing down firmly on the knife rotate the tubing until a ***single line*** can be seen all the way around the tubing.

(2) Grasp the tubing on each side of the score with smooth-jawed pliers, then flex the tubing back and forth through a small arc until it breaks at the score.

(3) If necessary, use a whetstone or a fine-tooth file to remove any burrs from the newly cut end of the tubing.

(4) Clean the tubing by flushing it with the following solvents in the order listed: acetone, isooctane or hexane, isopropanol, distilled water, concentrated nitric acid, distilled water, acetone. Finally, dry the tubing by flushing it with a clean, dry gas.

WARNING

POSSIBLE CHEMICAL REACTION

Do not discard the nitric acid and organic solvents into the same container.

2.10 USING OTHER DETECTORS

For convenience this paragraph summarizes the connections that must be made if the Model 5000 LC is used with other Varian detectors: the Vari-chrom variable wavelength detector, the Fluorichrom fluorescence detector, the refractive index detector, or the free-standing 254/280-nm UV Detector. Each should be placed as close to the column enclosure of the Model 5000 as possible and plumbed to the column exit with 0.009" ID stainless-steel tubing. Zero-dead-volume fittings should be used. The variable-backpressure restrictor should also be installed on the sample-cell outlet of all but the refractive index detector (see paragraph 2.11).

The electrical connections between each detector and the recorder (such as the Varian Model 9176) are illustrated in Figure 2-20. For more details on installation and operation, refer to the appropriate detector manual.

2.11 VARIABLE-BACKPRESSURE RESTRICTOR

The variable-backpressure restrictor is included in the standard accessory kit, along with the fittings necessary to attach it to the exit of the detector and to a 1/8" Teflon waste line. The restrictor should be used with all detectors, ***except*** the refractive-index detector, to eliminate bubbles in the sample flow cell. Attach the restrictor to the 1/16" OD tubing of the detector exit and to a waste line as shown in Figure 2-21. Make the 1/4" fittings at the restrictor before connecting it to the detector or attaching the waste line. The stainless-steel compression fittings should be tightened moderately, but the fitting on the Teflon waste line should be tightened only finger-tight. If the restrictor is used with the 254/280-nm UV Detector, it can be attached to the thermal jacket using the clip supplied with the detector.

The backpressure restrictor is adjusted at the factory to about 50 psi (4 atm). However, if it becomes misadjusted, or if it is necessary to adjust it to a different pressure, the following procedure can be used.

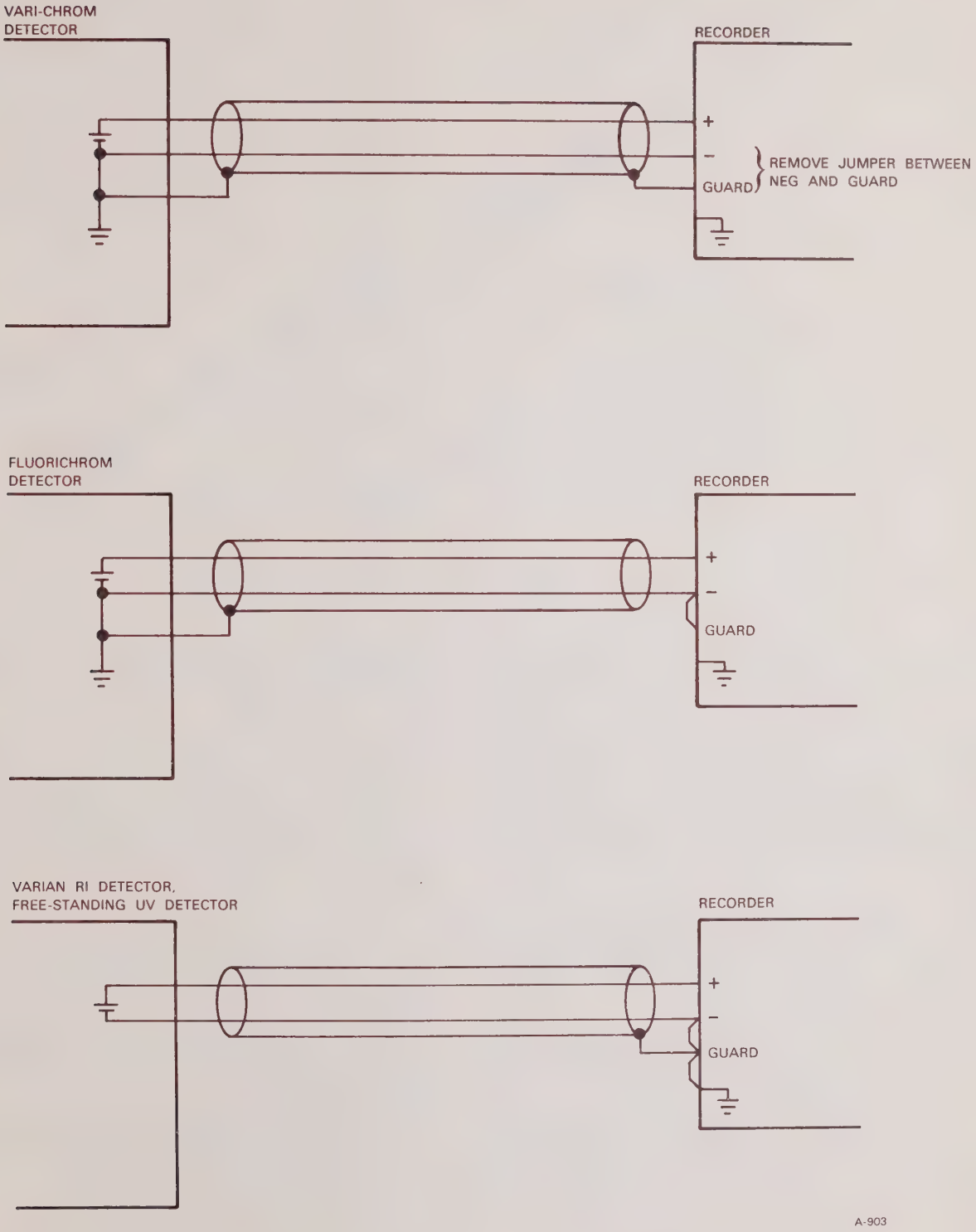


FIGURE 2-20 CONNECTIONS BETWEEN VARIAN DETECTORS AND A STRIP-CHART RECORDER

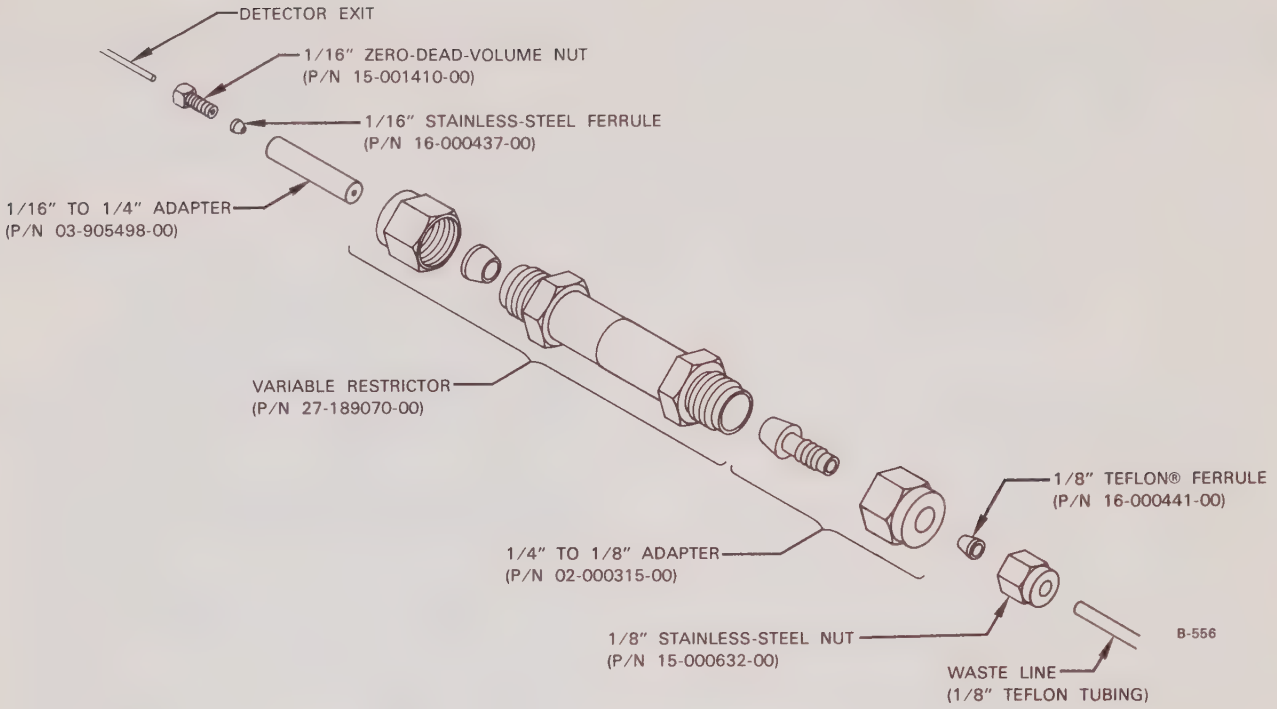


FIGURE 2-21 VARIABLE-BACKPRESSURE RESTRICTOR

(1) Remove the restrictor from the detector exit, and remove all fittings from the exit of the restrictor.

(2) Remove the side panel from the column enclosure, then remove the 1/16" tubing from the exit of the pressure transducer. Attach a short piece of 1/16" stainless-steel tubing (P/N 37-000654-00) to the transducer using a 1/16" stainless-steel ferrule (P/N 16-000437-00) and zero-dead-volume nut (P/N 15-001410-00).

(3) Set the flow rate to 2.0 ml/min, then start the pump, taking care to provide a waste container for the solvent flowing from the transducer. Check the pressure indicated on the CRT. It should be stable at 0 atm. Stop the pump.

(4) Using a second 1/16" ferrule and 1/16" nut, attach the variable restrictor to the tubing from the pressure transducer.

(5) Inside the exit of the variable restrictor are two Allen nuts, the outer one a locking nut, the inner one for adjustment of the backpressure. Using a 5/32" Allen wrench, loosen the outer nut about 1/3-turn. Turn on the pump.

CAUTION

Solvent will likely come in contact with the skin during adjustment of the restrictor; therefore, be sure only harmless solvents are being pumped.

(6) Use the 5/32" Allen wrench to engage ***both*** Allen nuts, then adjust the backpressure carefully until the CRT reads 5 atm (±1 atm). Stop the pump. Tighten the outer locking nut in the restrictor, then check the backpressure by again pumping at 2.0 ml/min. ***Ensure that the backpressure is no greater than 6 atm.***

(7) Replumb the pressure transducer, and reattach the variable restrictor to the detector.

SECTION 3
SYSTEM DESCRIPTION

3.1 GENERAL

Figure 3-1 shows two views of the Model 5000 LC illustrating many of the main features of the instrument, including the optional 254/280-nm UV Detector and optional column heater. This section provides a brief description of the major components of the Model 5000. It emphasizes the operating principles of the hydraulic components and the available injectors, and roughly sketches the design of the software

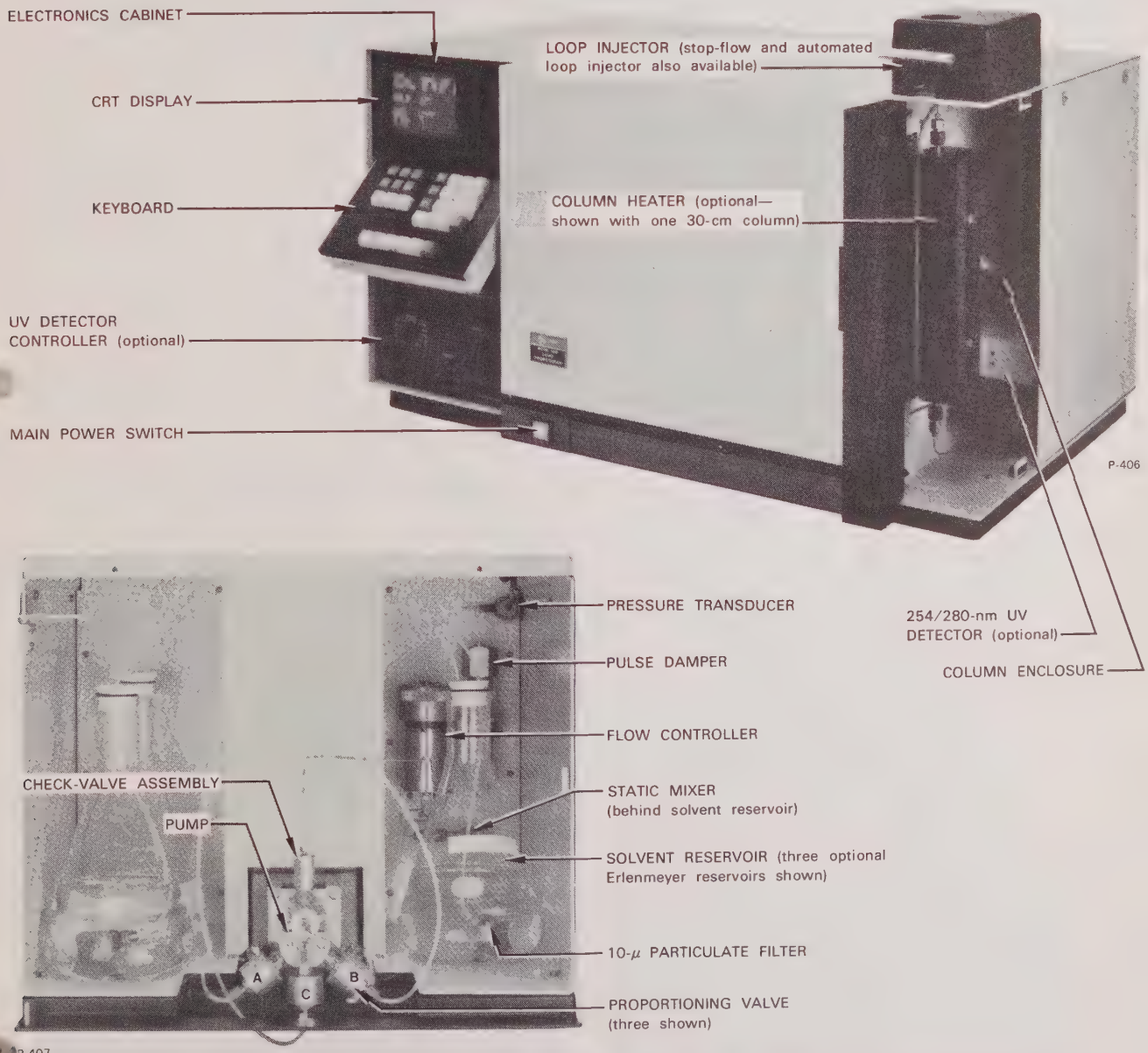


FIGURE 3-1 MODEL 5000, INCLUDING VIEW OF RESERVOIR COMPARTMENT

package. Descriptions of the keyboard and CRT display appear in Section 4; a description of the rear-panel connectors is in Section 2. Installation, operation, and maintenance of the components described here are covered elsewhere in the manual.

3.2 HYDRAULIC COMPONENTS

The components of the hydraulics system (which are illustrated schematically in Figure 3-2) provide an accurately metered mixture of solvents to the column head in a well-regulated, pulseless flow. The components include a pump, with as many as three proportioning valves, a flow controller to ensure that solvent flow rates are independent of column backpressure, a pulse damper to eliminate flow pulsations, and a pressure transducer to measure the pressure at the head of the column. These are described below.

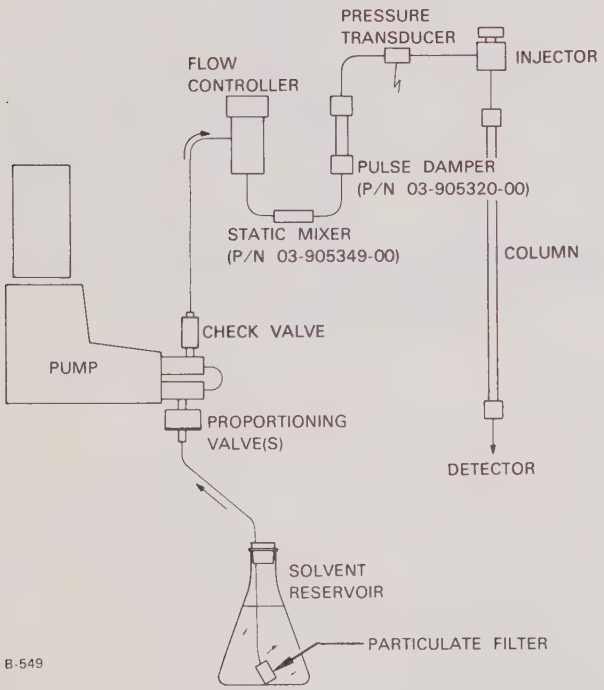


FIGURE 3-2 MODEL 5000 HYDRAULICS SYSTEM

3.2.1 Proportioning Valve (Figure 3-3)

The proportioning valves admit solvent from the solvent reservoirs to the pump. As many as three proportioning valves can be mounted on the inlet-valve head of the pump, any two of which can be selected to mix solvents in any ratio. The selection of valves (as well as the ratio of solvents) can be varied during each analysis. Each valve is opened by an electrical coil, which in turn is energized by the logic circuitry of the instrument according to the programmed solvent composition. During each fill stroke of the pump, one proportioning valve is always open; if two must be opened during a single stroke, they are opened sequentially. Figure 3-3 shows the solvent path through an open valve; when the coil is not energized the seal in the spring-loaded poppet closes the valve orifice.

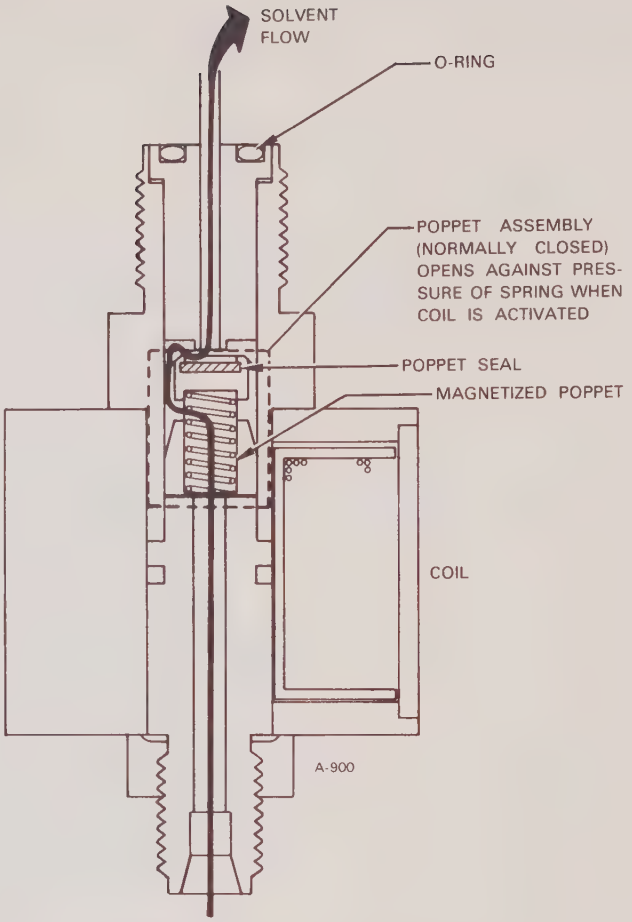
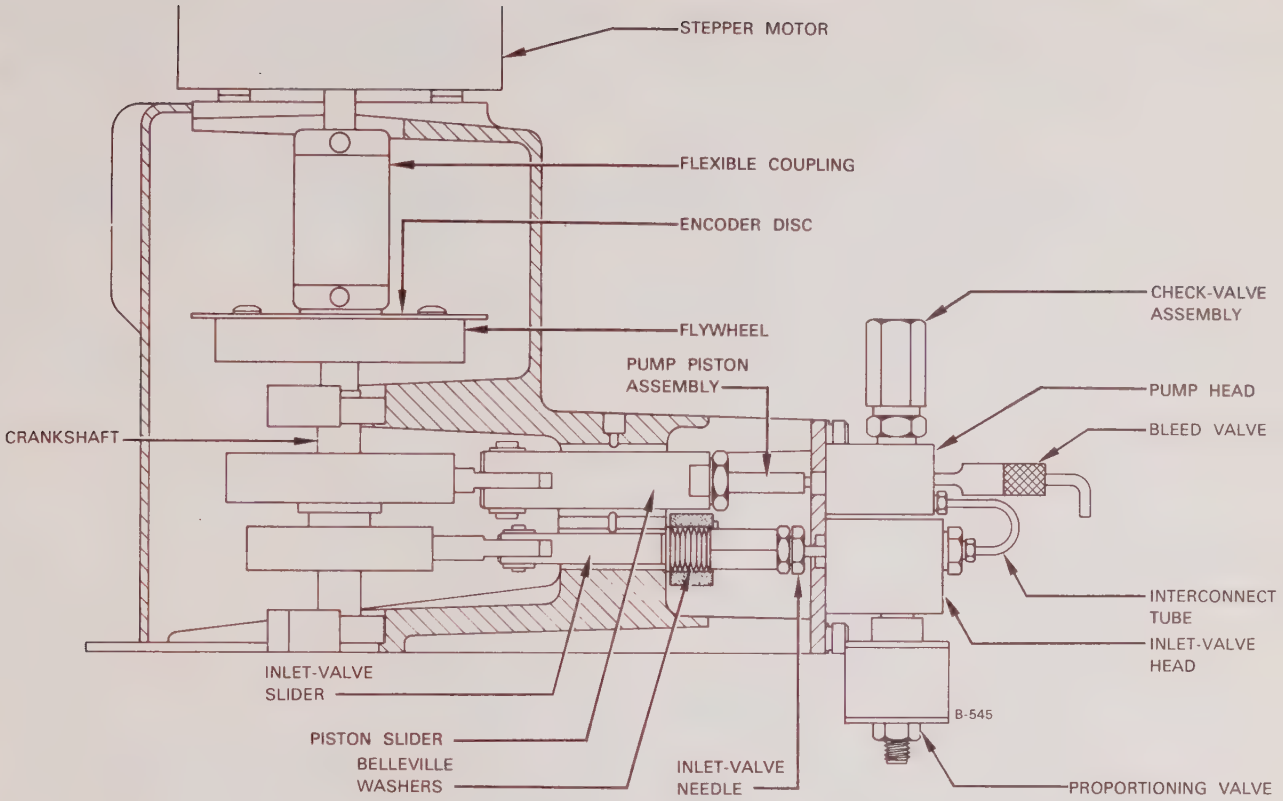


FIGURE 3-3 PROPORTIONING VALVE

3.2.2 Pump (Figure 3-4)

The single-piston, reciprocating pump is driven by a 200-pulse/revolution stepper motor. The motor is coupled to the crankshaft through a flexible coupling, which together with a flywheel and a weighted mechanical damper effectively eliminates stepper motor vibrations. The crankshaft includes two eccentric lobes: one drives the main pump piston, the second opens and closes the inlet valve through



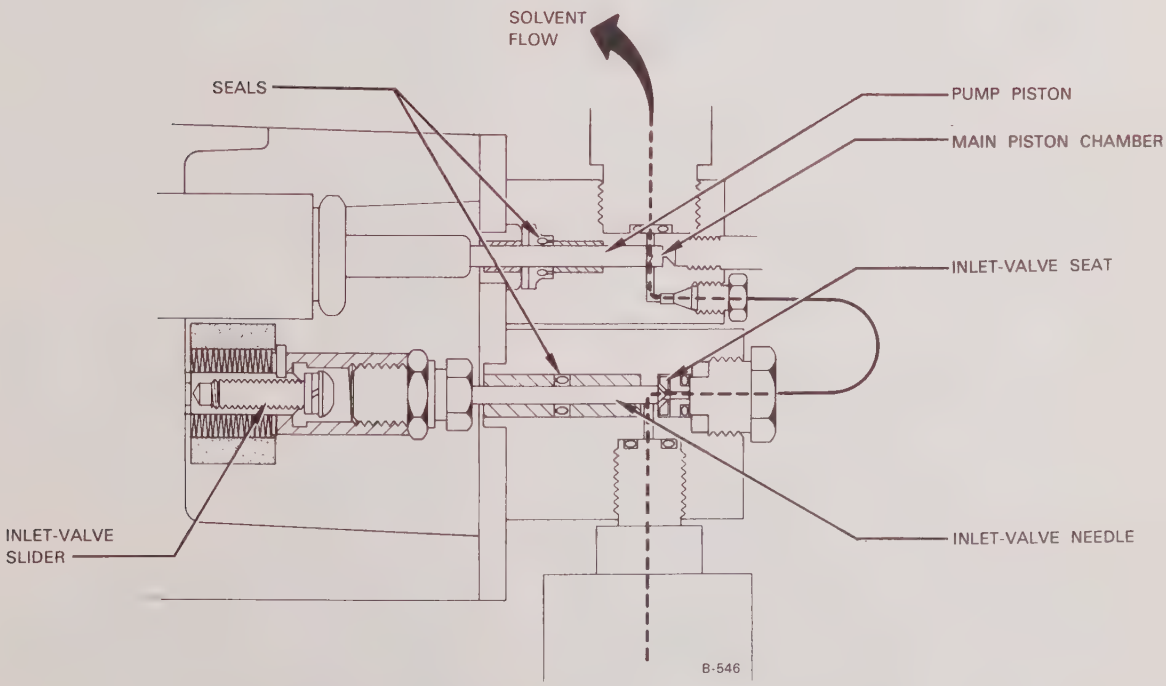


FIGURE 3-4 CUTAWAY VIEW OF PUMP, INCLUDING DETAIL OF PUMP AND INLET-VALVE HEADS

which solvent is admitted to the main pump chamber from the proportioning valves. Since the solvent is drawn from the reservoirs by the fill stroke of the pump, the solvent-delivery system depends upon neither gravity nor pressurized reservoirs.

The inlet-valve head, to which the proportioning valves are attached, contains the stainless-steel inlet-valve needle and the inlet-valve seat. During the fill stroke of the pump the valve is opened by the lower eccentric of the crankshaft; during the pump stroke the needle is seated by the pressure of the Belleville spring washers. (At the beginning of each fill stroke the inlet valve remains closed briefly to prevent any backflow from the piston chamber.) The inlet-valve head is connected to the pump head by a 1/16" interconnect tube. The pump head contains the pump piston and the main piston chamber, and carries the check-valve assembly and a bleed valve used for priming the pump. The pump piston, which delivers 90 μl of solvent during each stroke, is made of sapphire to reduce wear on the piston seals.

An encoder disc is mounted on top of the flywheel. Timing slots on the periphery of the disc are monitored by a stationary optical switch, which in turn provides the timing signals used by the pump- and valve-logic circuitry to open and close the proportioning valves and to control the velocity of the pump. The design of the pump cycle—including a variable-speed pump stroke and a rapid fill stroke—reduces the pulsations that would result if a constant angular velocity were translated directly into solvent flow.

3.2.3 Check-Valve Assembly (Figure 3-5)

The check-valve assembly, mounted on top of the pump head, closes the outlet line during the fill stroke of the pump. It comprises a 2-μ filter, to remove particulate contaminates from the solvent, and two ruby-ball/sapphire-seat check valves, the first spring loaded, the second actuated by solvent backpressure.

3.2.4 Flow Controller (Figure 3-6)

The adjustable, low-dead-volume flow controller is set at the factory to provide a constant 3500-psi resistance against which the solvent must be pumped. At column-head pressures below 3500 psi, therefore, the efficiency of the pump, which depends upon the compressibility of the solvent, will be constant for a given solvent system. If the column-head pressure exceeds 3500 psi the pump must work against the higher pressure and will therefore compress the solvent somewhat more: the efficiency of the pump will

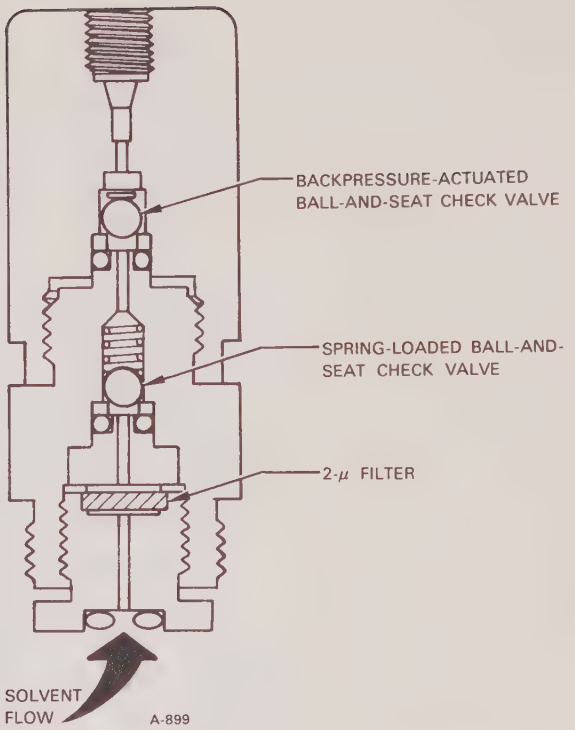


FIGURE 3-5 CHECK-VALVE ASSEMBLY

drop slightly. The choice of 3500 psi as the regulated backpressure was made to minimize the compressibility variations among different solvent systems, while providing a backpressure higher than most column backpressures. However, if column-head pressures above 3500 psi (238 atm) are encountered regularly, the regulated backpressure can be increased by turning the large adjustment knob, thus changing the tension on the pressure-regulator spring. Section 5 describes a procedure for making this adjustment.

As adjusted at the factory, the inner needle (see Figure 3-6) remains seated by the force of the small compression spring at solvent pressures below 3500 psi. As the pressure rises above 3500 psi it forces the outer needle upward, against the tension of the large pressure-regulator spring. The inner needle is thus drawn away from the needle seat allowing the solvent to flow.

3.2.5 Static Mixer

The static mixer is a short, relatively large diameter chamber having a volume of 0.7 ml. The dynamics of the solvent flow through the chamber ensures thorough mixing.

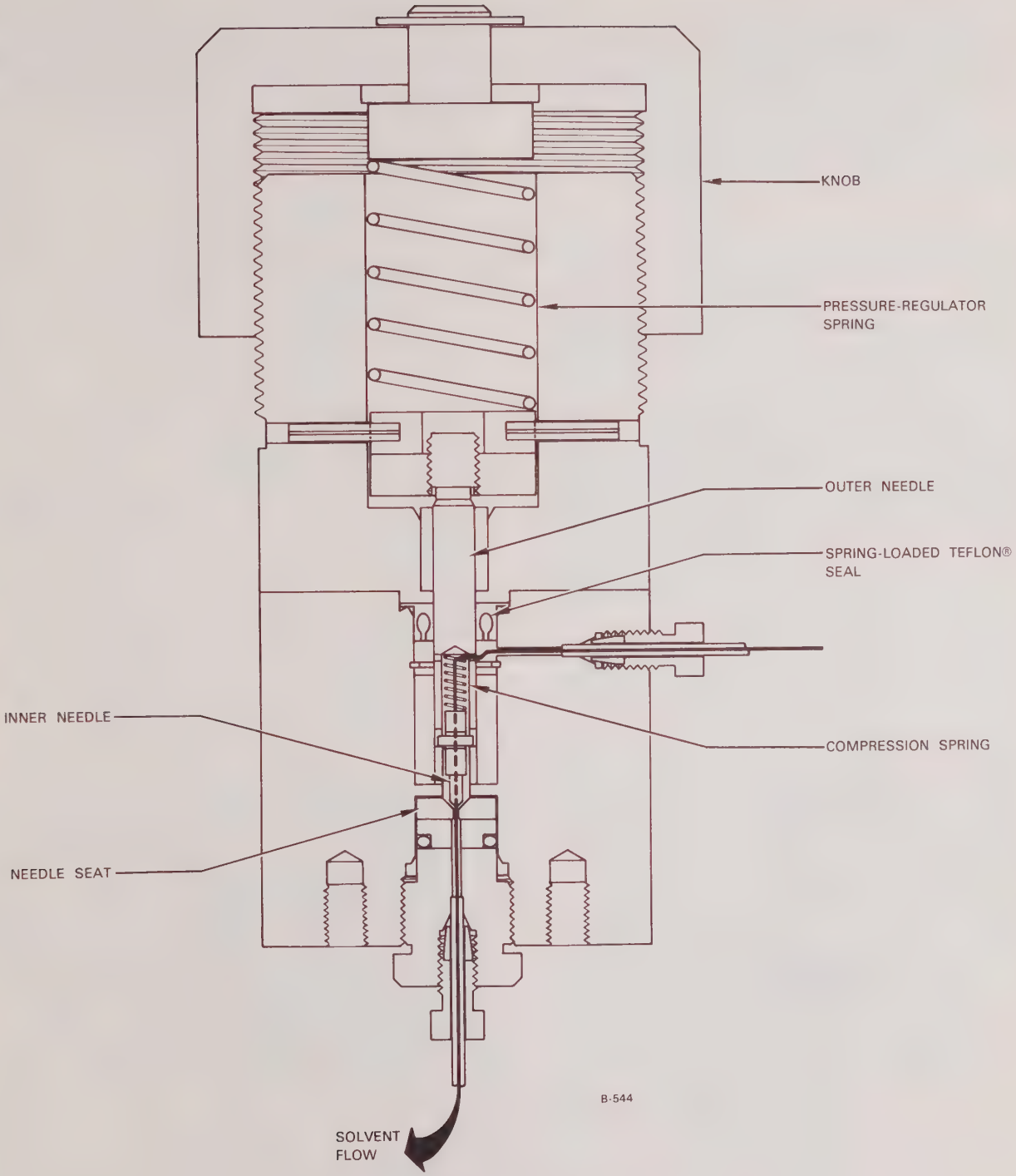


FIGURE 3-6 FLOW CONTROLLER

3.2.6 Pulse Damper

The in-line pulse damper ensures that any pressure and flow surges are isolated from the head of the column. The solvent flows through a length of flattened Teflon tubing immersed in a degassed, compressible fluid. The flexibility of the tubing and the compressibility of the fluid thus absorb any pressure fluctuations in the solvent stream. The total solvent volume in the pulse damper is less than 1.5 ml.

3.2.7 Pressure Transducer

The pressure at the head of the column is measured by a strain-sensitive semiconductor crystal whose resistance varies with the applied pressure. The pressure is continuously displayed on the CRT screen. During each pump stroke the central processor checks the pressure and compares it to the high- and low-pressure limits set by the operator.

3.3 INJECTORS

Three standard injectors are available from Varian for use with the Model 5000: a stop-flow injector, a manual 6-port, high-pressure loop injector, and an automatic loop injector.

3.3.1 Stop-Flow Injector (Figure 3-7)

The stop-flow injector is an in-line injection port that allows the sample to be introduced into the solvent stream at atmospheric pressure with a standard syringe. Before injection the pump must be stopped for a few seconds to allow the column-head pressure to drop to atmospheric pressure. With the injector plug tightened snugly, solvent flows directly to the column; with the plug slightly loosened, the solvent stream from the pump flows out the purge exit of the injector body, since it offers less resistance than the column. Operation of the stop-flow injector is discussed in more detail in Section 4.

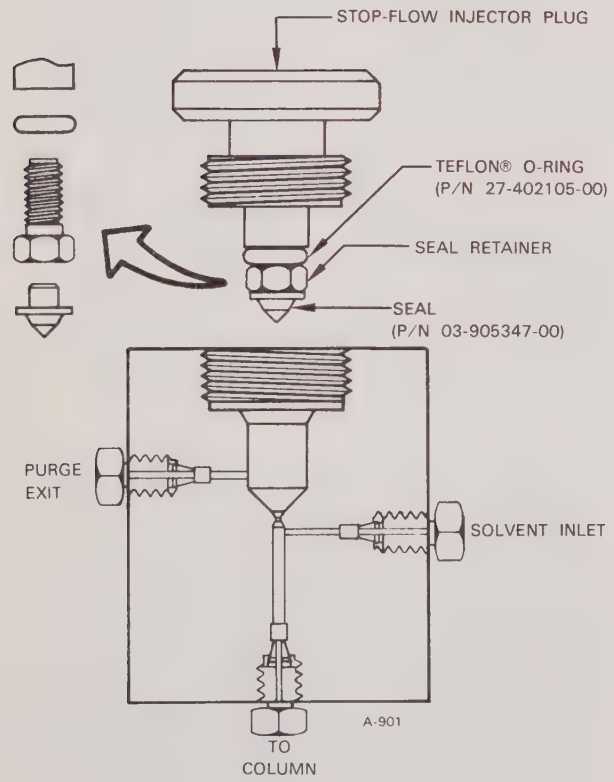


FIGURE 3-7 STOP-FLOW INJECTOR

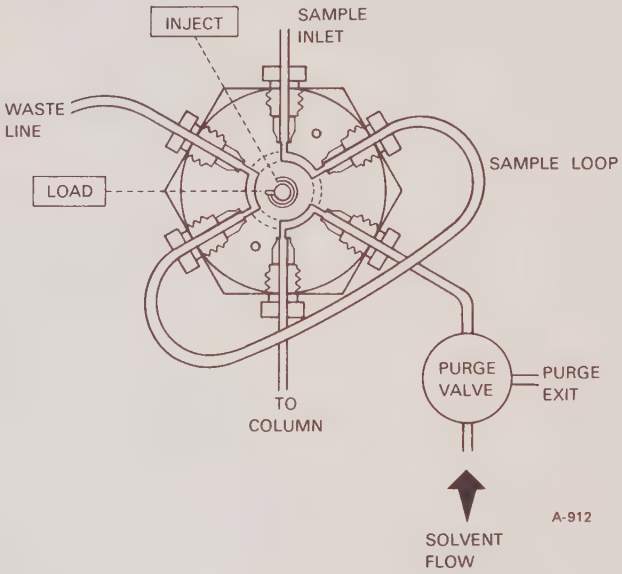


FIGURE 3-8 LOOP INJECTOR

3.3.2 High-Pressure Loop Injector (Figure 3-8)

The high-pressure loop injector allows the sample to be introduced into the solvent stream without stopping the solvent flow. Each valve is accompanied by a standard 10-μl sample loop and can be fitted with an optional specially calibrated syringe that permits accurate injections of less than 10 μl. Instruments equipped with the loop injector also have a purge valve between the pressure transducer and the solvent inlet of the injector: opening the purge valve allows the solvent stream to flow through the purge exit, thus purging the components upstream of the column. Operation of the loop injector is covered in Section 4.

3.3.3 Automatic Loop Injector

The automatic loop injector comprises the same 6-port valve illustrated in Figure 3-8 and a pneumatic actuator, which opens and closes the valve. Air pressure to the actuator is in turn controlled by an electrically operated valve in the column enclosure. This set-up allows the operator to build into his program automated control of the sampling cycle. An example appears in paragraph 4.2 as Example 3.

3.4 SOFTWARE

A central microprocessor is responsible for the logical and computational functions of the Model 5000. These functions can be grouped in six software blocks, or ***interrupts***, each of which requests attention as needed from the processor. To ensure that the microprocessor attends to the most important of these responsibilities first, the software designates a strict priority among them. The processor therefore responds to an input request by providing immediate service only if it is not currently processing a higher priority routine. The six interrupts are listed below, highest priority first, along with the functions they demand of the central processor.

- Power Up/Down. An 8-V battery, installed in each Model 5000 LC, ensures that the contents of memory will be saved when the instrument is turned off or when line power fails. (When the power is switched off at the instrument, line power will continue to charge the battery, and memory will be saved indefinitely. If line power fails, memory will be saved for about ten hours—until the battery is discharged.) When it senses a drop in voltage, the central processor immediately stores the current values of all program parameters, stops the pump, closes the proportioning valves, turns off the temperature controller, and disables access to the random-access memory (RAM). When power is restored the processor checks the memory to see if it is intact. If so, and if a program was running when the power failed, the instrument will resume operation with all parameters having the values they had before the power failure. A CRT message will indicate that the program was resumed. If a program was not running, the instrument will remain in a standby condition, and a CRT message will announce that memory has been saved. If memory has been lost (because the power failure has exceeded the battery life) preset parameters will be loaded when power resumes.

- Pump. At the beginning of each pump stroke, the processor determines the correct pumping speed from the programmed flow rate. Near the end of the pump stroke the processor checks the column-head pressure and compares it with the high- and low-pressure limits set by the operator, and from the programmed solvent composition determines the correct proportioning ratio for the following fill stroke.

- Output to CRT. Every 17 msec (20 msec for 50-Hz operation), the CRT controller requests the central processor to revise the CRT display using current values of operating conditions and programmable parameters.

- Real-Time Clock. The hardware of the Model 5000 includes a real-time clock, which interrupts the central processor every 60 msec, whereupon the processor checks a number of internal operating parameters. Every 600 msec the processor recalculates the values of time-dependent parameters, and every 6 sec it revises the ELAPSED TIME display and initiates the appropriate time-programmed events.

- Keyboard. The processor must respond to each keyboard entry, displaying the entry on the CRT when appropriate and reacting to operating-control keys such as **PUMP**, **START**, **DEL**, and **HOLD**. Whenever the **ENTER** key is struck, the processor checks for errors in the entry and stores the entry if it is legal. When the **DSPL** (Display) key is struck, the processor sorts the time-programmed entries and keeps only the most recent of conflicting entries. If the program listing is properly sorted, the **DSPL** key "turns the pages" of the program.

- CDS-111 Interface. If a Varian CDS 111L chromatography data system is installed, the processor selects the operating program in response to the CDS-111L file and provides information about the system requested by the CDS 111L (for example, that the high-pressure limit has been exceeded during a program).

SECTION 4
OPERATION

4.1 CRT DISPLAY AND KEYBOARD

To operate the Model 5000 LC little more is necessary than learning to read the CRT display and becoming familiar with the keyboard. The CRT screen displays all important current conditions of the instrument, including the status of any program being run. In addition, while a program is running, the CRT allows you to display the entire program; when a program is not being run, it is possible to display any program currently held in memory. The keyboard comprises all operating controls for the instrument (except those for the detector), keys to manipulate the CRT display, and keys to build ***operating programs*** — which may include gradient-elution and flow programs. This section describes the CRT display, and discusses in detail the keyboard and its use in program building, and describes how to operate the instrument. The section concludes with a summary of the routine operating procedures and a concise listing of keyboard-entry formats. This one-sheet outline is printed on heavy stock and can be kept with the instrument for easy reference.

4.1.1 CRT Display

Each operating program stored in memory can be displayed on the CRT screen as two (or if it is unusually long, three) separate "pages." As shown in Figure 4-1 the first page of each program is devoted mainly to a display of the current operating conditions of the instrument; the second (and third) to a listing of the program. If no values for the program parameters have been provided by the operator, the program listing will appear as shown in Figure 4-2. (If the temperature controller option is installed, the TEMP value will be the current column temperature.) The parameter values shown in this figure are called ***presets***.

When entries are being made by the operator in the program listing, each key will produce an entry in an entry field on the page that is currently displayed. Figure 4-2 shows the entry fields on pages 1 and 2. (The entry fields on pages 2 and 3 always appear immediately below the last time-programmed entry.) If the operator attempts to make an illegal entry or enters an illegal command, an error message will appear in the entry field. Entry formats, legal parameter values, and error messages are discussed in detail in paragraphs 4.1.3 through 4.1.5.

The CRT display also alerts the operator if line power to the instrument fails or if the power switch is inadvertently turned off. When power is restored the display announces the status of the instrument:

- if a program was running—

  POWER RECOVERED
  PROGRAM RESUMED
  USE DSPL KEY TO EXAMINE STATUS

- if a program was not running—

  POWER RECOVERED
  PROGRAMS SAVED
  USE DSPL KEY TO EXAMINE STATUS

- if the programs have been lost from memory—

  POWER RECOVERED
  PRESETS LOADED
  USE DSPL KEY TO EXAMINE STATUS

4.1.2 Keyboard Description

The keyboard of the Model 5000 combines the operating controls of the instrument with keys to manipulate the CRT display and to build and run a variety of operating programs. The hinged keyboard swings up from the front panel of the instrument into a convenient operating position, but the keyboard is functional in either position. As shown in Figure 4-3 the operating controls comprise a row of six keys at the bottom of the panel; the program parameters are controlled by a second group of keys; and a third group includes the numeric keys as well as the **CE** (Clear Entry), **DSPL** (Display), **DEL** (Delete), and **ENTER** keys. Figure 4-3 also includes a description of the functions of each key. Further discussion of the operating controls will be reserved for paragraph 4.3 on routine operation; the paragraphs below describe in detail how the remaining keys are used to build operating programs and to manipulate the CRT display.

A keyboard lockout switch is located on the rear of the keyboard panel, under the left-hand side. When switched down (toward the bottom of the keyboard) this switch disables all keys except **DSPL**, and the word RMT (Remote) appears on the display following the program number. In

this position the switch insures against inadvertent changes being made in a program if a key is struck during an analysis.

4.1.3 Building a Program

Each analysis program includes values for the non-time-programmable parameters PMAX, PMIN, and SET (the column temperature); a specified ANALOG OUT signal; and a listing of time-programmable parameters, which may include FLOW, %, RSVR, EVNT, and PRGM. This paragraph explains how to enter or change these values; paragraph 4.2 will discuss in more detail practical aspects of program building. The allowed values for the program parameters are tabulated in Table 4-1.

TABLE 4-1
ALLOWED VALUES FOR PROGRAM PARAMETERS

Parameter	Allowed Values
TIME	0.0 - 999.9 minutes, integers may be entered without decimal point
FLOW	0.0 - 15.0 ml/min, integers may be entered without decimal point
%	0 - 100%, integral values only
PRGM	1 - 9
RSVR	AB, AC, BC, A, B, C; only pump-inlet ports with proportioning valves installed can be specified
EVNT	0 - 15 (see Table 4-2)
PMAX, PMIN	0 - 350 atmospheres, integral values only
TEMP	0 - 140°C, integral values only; if 0°C is selected the temperature controller is turned off (for other limits on the operating temperature of the column heaters, see paragraph 2.9.5 and the **NOTE** on this page

There are also limits on the rates at which the flow rate and the solvent composition can be changed during an operating program. If the program specifies linear changes (as described in paragraph 4.2) for the flow or the composition that exceed these limits, the change will appear as a step. The step will occur six seconds after the beginning of the specified linear segment.

Parameter	Maximum Rate of Change
FLOW	1.0 ml/min per 6-second interval
%	10% per 6-second interval

TABLE 4-2
EXTERNAL EVENTS CODE

Events Activated[1]	Parameter Value[2]	
None		= 0
1	1	= 1
2	2	= 2
3	4	= 4
4	8	= 8
1 & 2	1 + 2	= 3
1 & 3	1 + 4	= 5
1 & 4	1 + 8	= 9
2 & 3	2 + 4	= 6
2 & 4	2 + 8	= 10
3 & 4	4 + 8	= 12
1 & 2 & 3	1 + 2 + 4	= 7
1 & 2 & 4	1 + 2 + 8	= 11
1 & 3 & 4	1 + 4 + 8	= 13
2 & 3 & 4	2 + 4 + 8	= 14
1 & 2 & 3 & 4	1 + 2 + 4 + 8	= 15

[1]Events 1 & 2 are contact closures; events 3 & 4 are optional 115-V outputs (see paragraph 2.6.2).

[2]The parameter values entered on the keyboard can be calculated by assigning event 1 a numeric value of 1, event 2 a value of 2, event 3 a value of 4, and event 4 a value of 8, then adding the appropriate numeric values.

- **Entering PMAX, PMIN, SET (TEMP key)**

parameter key + *new value* + ENTER

The values for these non-time-programmable parameters can be changed at any time; the new values take effect immediately even if a program is running.

NOTE

As a safety feature the circuitry of the temperature controller limits the operating temperature of the column heaters to 75°C. If the temperature is programmed to exceed this limit, the temperature controller will shut off completely when the temperature reaches 75°C. It is then necessary to turn the main power switch of the instrument off, then on, to reactivate the temperature controller. To change the temperature limit to 150°C, see paragraph 2.9.5.

CURRENT CONDITIONS

PUMP status: RUNNING, PURGING, or STOPPED.

PROGRAM status: RUNNING, COMPLETE, or STOPPED

ELAPSED TIME: the elapsed time of the program in minutes

COMPOSITION: the solvent composition, displayed as percent of the second reservoir listed below. If only one reservoir is listed, the solvent composition should be 100%

FLOW RATE: the total flow rate of the solvent mixture in milliliters per minute. If the pump is stopped the display will show the rate at which the solvent will be pumped when operation resumes

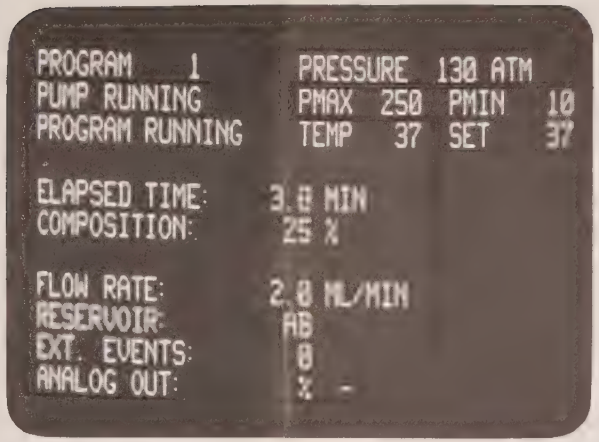
RESERVOIR: the reservoir(s) from which solvent is being drawn

EXT EVENTS: the external events currently being activated (see Table 4-2)

ANALOG OUT.: the signal currently appearing at the rear-panel ANALOG OUTPUT plug—may be composition (%), flow rate (FLOW), or column-head pressure (P)

PRESSURE: the current column-head pressure.

TEMP: the current column temperature in degrees Celsius. If the temperature controller option is not installed, this display will not appear



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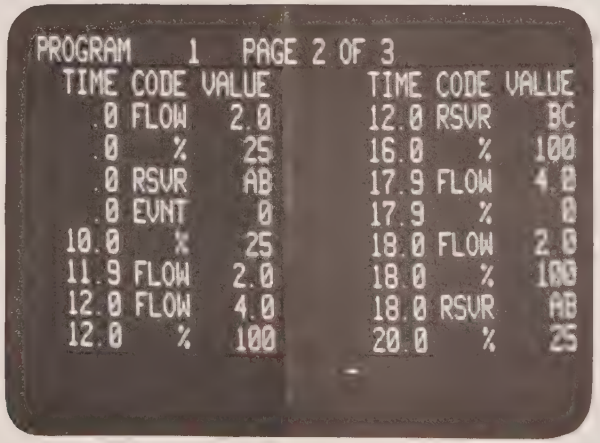
OPERATING PARAMETERS

these parameters can be changed while the program is running

PMAX: the maximum allowable value for the column-head pressure in atmospheres. If PMAX is exceeded a flashing flag will appear on the display next to PMAX and the pump will stop until the pressure drops, then restart; if it is exceeded four times during any ten consecutive pump strokes, the pump will stop and will not restart automatically

PMIN: the minimum allowable value for the column-head pressure in atmospheres. If the pressure drops below PMIN after the pump has been running for 30 seconds, a flashing flag will appear on the display next to PMIN and the pump will stop. If the pump is purging, PMIN is ignored

SET: the temperature (in degrees Celsius) set by the operator for the column heater. If the column temperature (TEMP) is more than 2° above or below the value set, a flashing flag will appear next to SET. If the temperature controller option is not installed, this display will not appear



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PROGRAM LISTING

the listing cannot be changed while the program is running

Each line of the program listing indicates the TIME (in minutes) at which the programmable parameter (CODE) will take the VALUE indicated. As discussed in paragraph 4.1.2 the available programmable parameters are solvent flow rate (FLOW), solvent composition (%), the reservoir(s) from which the solvent is drawn (RSVR), external events (EVNT), and a switch to another operating program (PRGM). More will be said about programming these parameters in paragraphs 4.1.3 and 4.2

FIGURE 4-1 CRT DISPLAY

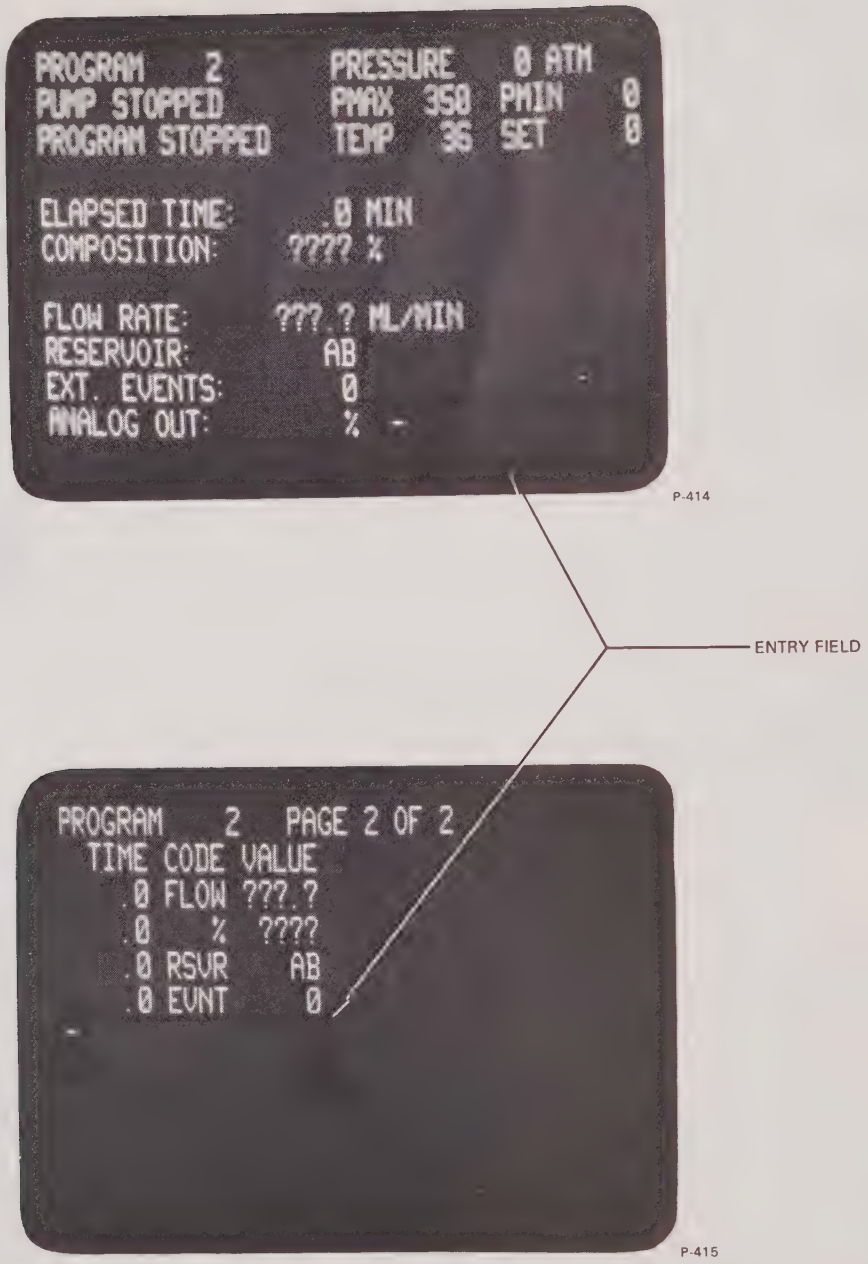


FIGURE 4-2 CRT DISPLAY SHOWING PRESET PARAMETER VALUES AND ENTRY FIELDS

TIME-PROGRAMMABLE PARAMETERS

these keys cannot be used while an operating program is running

TIME: always followed by a numeric value (in minutes) and used with one of the following time-programmable parameters. Used to specify the time for a parameter being entered into or deleted from a program

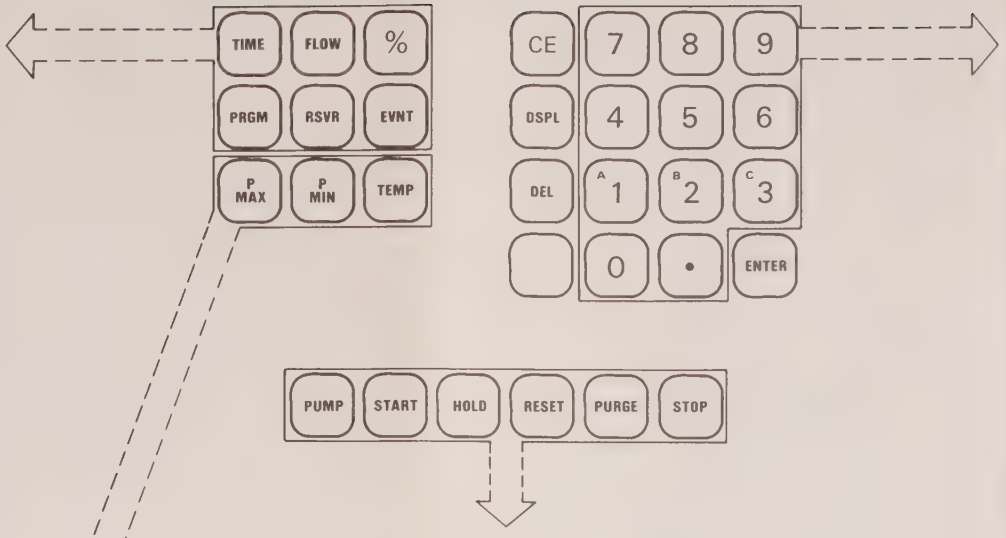
FLOW: always used with the **TIME** key (and a time value), either to enter a flow rate value (in ml/min) into a program, to delete a flow rate entry from a program, or to change the ANALOG OUT signal to FLOW

%: always used with the **TIME** key (and a time value), either to enter a solvent composition value into a program, to delete a composition entry from a program, or to change the ANALOG OUT signal to %. Solvent composition is always given as percent of the second of the two reservoirs being used (or as 100% if only one reservoir is listed)

PRGM: always used with the **TIME** key (and a time value), either to display a program on the CRT screen, to delete a program from memory, to copy one program into another, to enter a program-switch command into a program, or to delete a program-switch command from a program.

RSVR: always used with the **TIME** key (and a time value), either to specify the reservoir(s) to be used during a program or to delete a reservoir entry from a program

EVNT: always used with the **TIME** key (and a time value), either to specify the external events to be activated during a program or to delete an event entry from a program



NUMERIC KEYS

These keys are used to specify time and parameter values. Keys **1**, **2**, and **3** are also used to specify reservoirs A, B, and C, as shown by the superscripts on the faces of the keys. The decimal-point key also has a special function—changing the ANALOG OUT signal (see paragraph 4.1.3)

NON-TIME-PROGRAMMABLE PARAMETERS

PMAX: used to specify the maximum allowable column-head pressure or to change the ANALOG OUT signal to P

PMIN: used to specify the minimum allowable column-head pressure or to change the ANALOG OUT signal to P

TEMP: used to specify the column temperature; appears on the CRT display as SET.

OPERATING CONTROLS

PUMP: starts the pump. The flow rate and the solvent composition must be specified in the program

START: starts the program currently displayed on the CRT screen. If the program status is STOPPED, the program will start (or resume) at the time shown as ELAPSED TIME. If ELAPSED TIME = .0 MIN and initial program parameters have not been specified, an error message appears. If the program status is COMPLETE, the program will be reset to ELAPSED TIME = .0 MIN, then restarted. (There is one exception to these rules: after a program is completed, if the **STOP** key is struck— thus changing the status to STOPPED— then the **START** key, the program will restart at TIME = .0 MIN.)

HOLD: halts the program. All program parameters retain their current values and the pump continues to run

RESET: resets the elapsed time to zero and all program parameters to their initial values. If the pump is running it continues to run, but the program must be restarted by striking the **START** key

PURGE: starts the pump at a flow rate of 10 ml/min. The **PURGE** key will not function if a program is running or if no initial solvent composition is specified

STOP: halts the pump and the program. The elapsed time retains its current value

OTHER FUNCTIONAL KEYS

CE (Clear Entry): clears the entry field, including any error messages

DSPL (Display): used to sort the time-programmable entries in a program or to "turn the pages" of a program

DEL (Delete): used with the **TIME** key (and a time value) and a parameter key to delete an entry from a program or to delete an entire program

ENTER used to process the contents of the entry field; thus all instructions involving the programmable- and nonprogrammable-parameter keys are implemented only after the **ENTER** key is struck

Blank key: has no function; striking it produces an error message on the CRT screen

FIGURE 4-3 MODEL 5000 KEYBOARD

- **Entering Time-Programmable Parameters**

[TIME] + *time value* + *parameter key* + *parameter value* + [ENTER]

This entry format is the essential program-building tool. As illustrated in paragraph 4.2, it allows the operator to design operating programs in which flow rate, solvents, and solvent composition vary as a function of time, and in which external events can be automatically activated. It is also possible to switch automatically from the end of one program to the beginning of another. However, these time-programmed entries can be made only when the displayed program is stopped or complete.

The above format is always legal; however, several variations will be accepted by the processor. For example, the parameter and parameter value may precede **TIME** and the time value (*parameter* + *parameter value* + **TIME** + *time value* + **ENTER**). Also, if a series of entries is to be executed at the same time in the program, only the first of the consecutive entries must include the **TIME** key and the time value. Subsequently (assuming the **CE**, **DSPL**, **DEL**, or any of the operating-control keys is not struck in the meantime) only the parameter and the parameter value must be selected (*parameter* + *parameter value* + **ENTER**). Likewise, if the same parameter and parameter value are to appear at different times in the program, and if the entries are made consecutively, only the first entry must include the parameter key and parameter value (again assuming that none of the keys listed above has been used in the meantime)—**TIME** + *time value* + **ENTER**. Examples of this flexibility appear in Example 4 in paragraph 4.2. Furthermore, entries need not be made in the correct time sequence. They will be sorted chronologically when the **DSPL** key (see paragraph 4.1.4) or **START** key is depressed. Likewise, if two or more entries are made for the same time and same parameter, each will be displayed until the **DSPL** or **START** key is struck, at which time all but the one most recently entered will be discarded.

Any time-programmed entry made when the program is complete, or made for any time ***earlier*** than the current elapsed time (if the program is stopped), will not be executed until the program is reset and run again.

- **Selecting ANALOG OUT**

[TIME] + *any legal value* + [FLOW] or [%] + [•] + [•] + [ENTER]

or

[P MAX] or [P MIN] + [•] + [•] + [ENTER]

If the ANALOG OUT signal is to be either flow rate or solvent composition, the entry must include an arbitrary time value since **FLOW** and **%** are processed as time-programmable parameters. Thus these commands can be given only when the program is stopped or complete. (Note, however, that the ANALOG OUT signal is ***not*** a time-programmable parameter that becomes part of the operating-program listing.) To change the output signal to column-head pressure, a time value is not needed. Either **PMAX** or **PMIN** can be used, and the command can be given when the program is running.

4.1.4 Manipulating the CRT Display

The memory can store as many as nine operating programs, each of which comprises two or three pages. Any of these pages can be displayed on the CRT screen by entering the proper command. In addition the entire contents of any program can be deleted or can be duplicated, thus appearing as two separate programs, and individual program entries can be deleted without altering the rest of the program.

- **Displaying a New Program**

[TIME] + *elapsed time or zero* + [PRGM] + *new program number* + [ENTER]

This command can be given only when the current program is stopped or complete. When the new program is displayed, the elapsed time will be reset to zero. If the pump was running, it will continue to run if the new program specifies values for flow rate and solvent composition. The old program is ***not*** deleted from memory when a new one is displayed.

- **Deleting a Program**

TIME + 0 + PRGM + DEL (display will show DELETE PROGRAM?) + ENTER (any other key will abort the delete command and clear the entry field)

This command can be given only when the current program is stopped or complete. ***It can be used to delete only the program currently displayed.*** When a program is deleted, presets immediately appear for all parameters in the deleted program.

- **Duplicating a Program**

TIME + *any legal value* + PRGM + *program number to be duplicated* + • + *new program number* + ENTER (display will show MOVE PROGRAM?) + ENTER (any other command will abort the move command and clear the entry field)

This command can be given only when the current program is stopped or complete. The duplicated program is not erased, but now appears in two locations. The new program is displayed, with the elapsed time reset to zero; the pump is stopped.

- **Deleting a Time-Programmed Entry**

TIME + *time of entry to be deleted* + *parameter to be deleted* + DEL

This command can be given only when the program is stopped or complete, and cannot be used to delete entries at TIME = .0 MIN. ***Only entries in the program currently displayed can be deleted.***

- **Using the DSPL Key**

The **DSPL** (Display) key has two uses: to sort the entries in a program listing, and to "turn the pages" of the program displayed on the CRT screen. The sorting routine sorts the entries and displays them in the order they will be executed by the program. If redundant or conflicting entries appear, all but the most recent are deleted. If two or more parameters have the same time value, they are sorted in the following order: FLOW, %, RSVR, EVNT, PRGM. If the program listing is properly sorted, striking **DSPL** displays the next page of the program: page 1→page 2 → page 3 (if needed)→page 1.

4.1.5 Display Messages

Under a variety of circumstances, display messages appear in the entry field of the CRT screen. Often these messages indicate that the processor has been unable to interpret an entry or is unable to execute it. Table 4-3 tabulates these messages and provides an interpretation of each.

TABLE 4-3
DISPLAY MESSAGES

Message	Meaning
CANNOT FIND	A parameter to be deleted cannot be found on the program list.
DELETE PROGRAM?	Confirm delete command by striking **ENTER**.
ENTER TIME & FLOW	Enter initial value for flow rate before trying to run the pump or a program.
ENTER TIME & %	Enter initial value of solvent composition before running the pump or a program.
INCOMPLETE	An entry has at least one element missing.
ILLEGAL COMMAND	The processor cannot make sense of the entry; the command cannot be executed or is improperly formatted. (See paragraphs 4.1.3 and 4.1.4.)
ILLEGAL VALUE	A numeric entry exceeds the limits for the specified parameter.
MOVE PROGRAM?	Confirm command to duplicate program by striking **ENTER**.
PROGRAM FULL	The available 32 lines of the program listing have been filled.
PURGING	The system is being purged at a flow rate of 10 ml/min.
RESERVOIR EMPTY	An inlet port (reservoir) has been specified for which there is no proportioning valve. This message also appears above the elapsed time on page 1.
RSVR - % CONFLICT	Only a single reservoir has been selected, but the solvent composition selected is not 100%.

TABLE 4-3
DISPLAY MESSAGES (Cont.)

Message	Meaning
RUNNING	A program is running; no time-programmed events can be entered.
UNKNOWN KEY	The unlabeled key has been struck.

4.2 PRACTICAL PROGRAM BUILDING

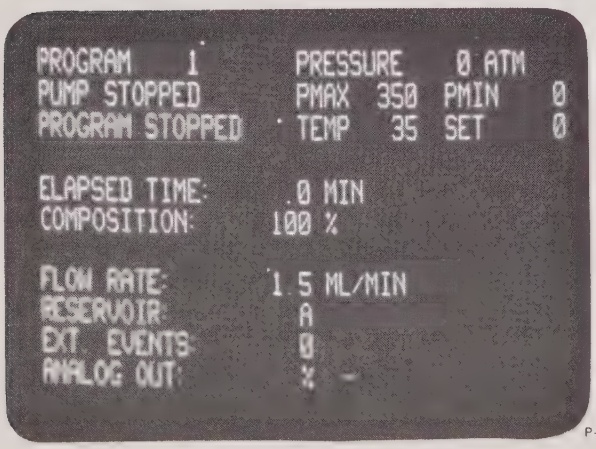
This paragraph is not intended to provide practical guidelines for selecting the proper operating programs for your needs; however, it will describe four typical programs, showing how they are built and entered into the system's memory. This discussion therefore supplements paragraphs 4.1.3 and 4.1.4 by illustrating the uses of the keyboard. Examples 1 and 2 are typical, simple examples (one isocratic, the second a gradient-elution program) of operating programs for an LC system in which neither an Auto-Sampler nor a chromatography data system is installed.

- Example 1—Isocratic Analysis. To run a simple isocratic analysis, with a single solvent, you must specify only the correct solvent reservoir and flow rate, making sure that the solvent composition is 100%. Figure 4-4a shows the entries necessary for a typical isocratic run. Figure 4-4b illustrates the CRT display that results: preset values appear for EXT. EVENTS, ANALOG OUT, PMAX, PMIN, and SET.

(a)

TIME + 0 + PRGM + 1 + ENTER	Displays program 1.
TIME + 0 + PRGM + DEL (DELETE PROGRAM? displayed) + **ENTER**	Deletes previous program 1 and loads presets.
TIME + 0 + RSVR + 1 + ENTER	Specifies that solvent will come from reservoir A (see Figure 3-1).
TIME + 0 + % + 100 + ENTER	Since only a single reservoir is being used, the solvent composition must be 100%
TIME + 0 + FLOW + 1.5 + ENTER	Specifies a flow rate of 1.5 ml/min.
TIME + 20 + FLOW + 1.5 + ENTER	The program status display will show COMPLETE after this last program entry is executed. It has no other effect than to "end" the program; the pump continues to run and the ELAPSED TIME display continues to increase. Any other time-programmed entry at TIME = 20.0 MIN would have had the same effect of ending the program after 20 minutes.

(b)



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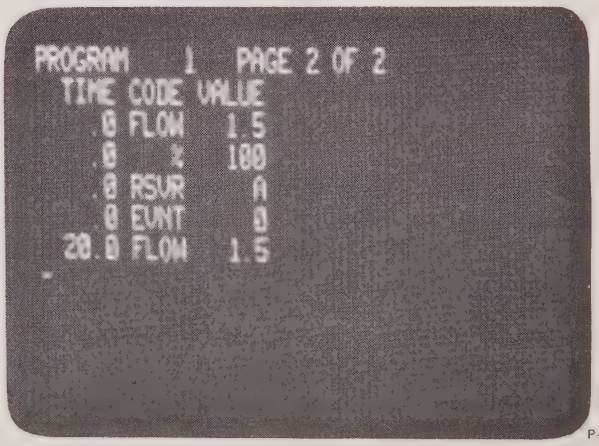

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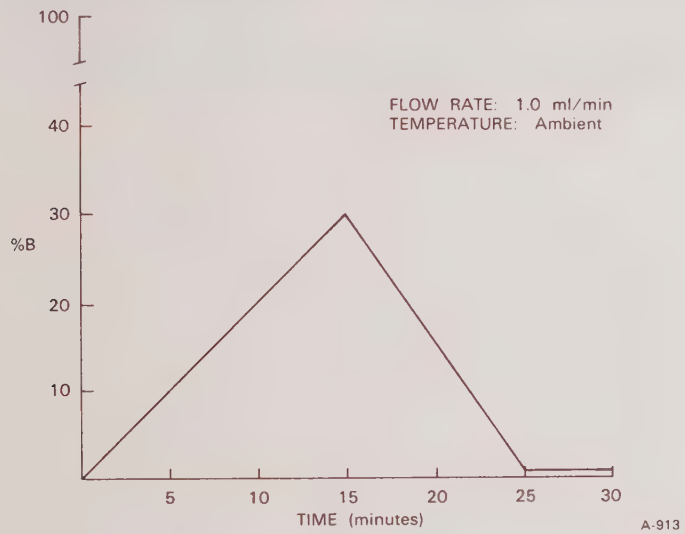
FIGURE 4-4 OPERATING PROGRAM—EXAMPLE 1 (a) Keyboard Entries, (b) CRT Display

- Example 2—Linear Gradient and Regeneration. Figure 4-5a illustrates a simple gradient-elution profile, including a programmed regeneration of the initial conditions. Figure 4-5b shows the entries that are necessary to build and store this program. As this example shows, ***a linear elution gradient is specified by entering the appropriate values for TIME and % at the endpoints of every linear segment.*** A flow program can be entered in exactly the same way. Both flow rate and solvent composition will then remain constant at the last value specified until the end of the program. The other time-programmable parameters (RSVR, EVNT, PRGM) designate discrete events that occur at the time indicated and remain effective until explicitly changed. This program will be run at ambient temperature (preset: SET = 0, thus the temperature controller is off), no external events will be activated (preset: EXT. EVENTS = 0), the ANALOG OUT signal will not be used (preset: ANALOG OUT = %), and solvent will be drawn from reservoirs A and B (preset: RSVR = AB). Figure 4-5c shows pages 1 and 2 of the CRT display after the program has been entered.

(a)

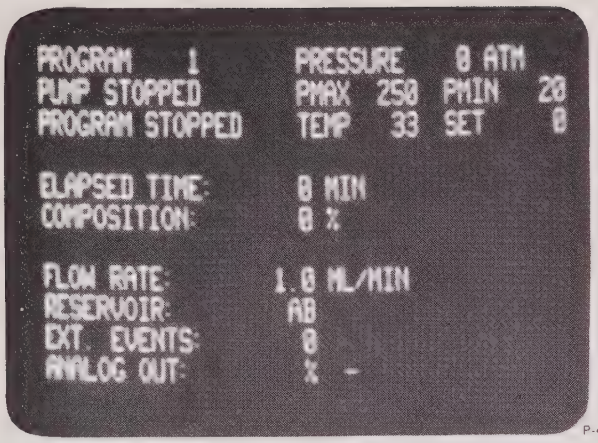


(b)

TIME + 0 + PRGM + 1 + ENTER	
TIME + 0 + PRGM + DEL (DELETE PROGRAM? displayed) + **ENTER**	
TIME + 0 + % + ENTER **TIME + 0 + FLOW + 1.0 + ENTER**	These two entries enter initial values for the flow rate and the solvent composition; since no subsequent flow rate is specified, it will remain constant throughout the program.
TIME + 15 + % + 30 + ENTER	Specifies that the solvent composition will increase linearly from 0%B to 30%B during the first 15 minutes of the program, i.e., increase at 2%/min.
TIME + 25 + % + 0 + ENTER	Specifies that the solvent composition will decrease linearly from 30%B to 0%B during the next 10 minutes of the program, i.e., decrease at 3%/min.
TIME + 30 + % + 0 + ENTER	Specifies that the solvent composition will remain constant during the last five minutes of the program; since this is the last entry in the program listing, the program status display will show COMPLETE at 30 minutes, but the pump will continue to run and the ELAPSED TIME display will continue to increase.
PMAX + 250 + ENTER	Sets the maximum allowable pressure to 250 atm.
PMIN + 20 + ENTER	Sets the minimum allowable pressure to 20 atm; this ensures that the pump will shut off if a serious leak causes the pressure to drop.

FIGURE 4-5 OPERATING PROGRAM—EXAMPLE 2
(a) Gradient-Elution Profile, (b) Keyboard Entries, (c) CRT Display

(c)



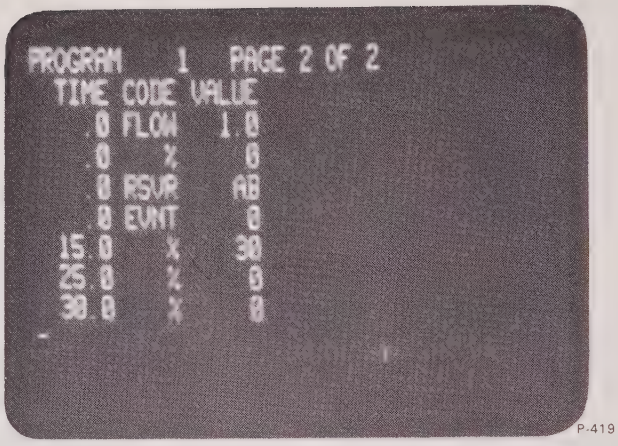


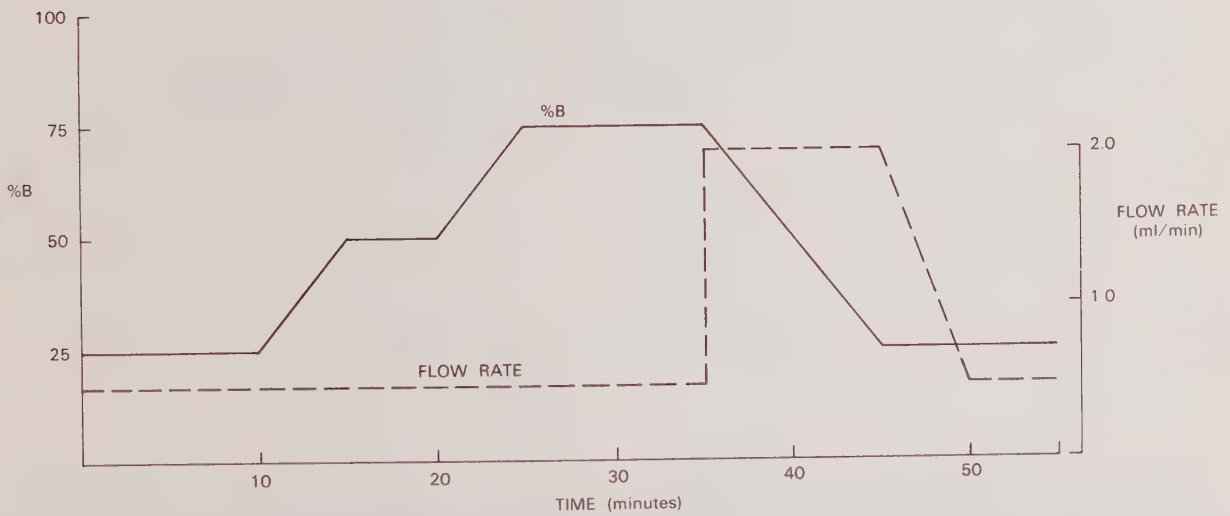
FIGURE 4-5 OPERATING PROGRAM—EXAMPLE 2
(a) Gradient-Elution Profile, (b) Keyboard Entries, (c) CRT Display (Cont.)

Example 3 is a more complicated gradient-elution program. It includes an illustration of the use of flow programming (to hasten the regeneration of initial conditions), as well as the use of the temperature controller, the ANALOG OUT output, and the external events. Again, the system contains no AutoSampler or CDS 111L, but it is assumed to be equipped with an automatic loop injector powered by external event 3.

- Example 3—Elution Gradient with Flow Programming. Figure 4-6a shows a complex elution profile, along with the flow rate for the program. In this example, the ANALOG OUT signal will be the column-head pressure and the column temperature will be 33°C. External event 3 (one of the optional powered events) will be activated at the beginning of program 1, then turned off after 50 minutes. After 55 minutes, program 1 will restart automatically. As part of an on-line analysis system, this program would therefore automatically inject and analyze a new sample every 55 minutes.

This example also includes a second program, which allows the initial conditions of program 1 to equilibrate before it actually begins. Program 2 therefore establishes all of the initial conditions of program 1, except that event 3 is not yet activated. When the conditions have stabilized, program 2 can be started; after 30 seconds it will switch to program 1 and the first sample will be injected. In the ensuing cycle of analyses, program 2 will never reappear. Figures 4-6b and 4-6c show the entries necessary for programs 1 and 2, and the resulting display for program 1.

(a)



(b)

TIME + 0 + PRGM + 1 + ENTER

TIME + 0 + PRGM + DEL

(DELETE PROGRAM? displayed) + **ENTER**

TIME + 0 + FLOW + .5 + ENTER

TIME + 35 + FLOW + .5 + ENTER

TIME + 35.1 + FLOW + 2 + ENTER

This entry specifies a linear flow rate change of 1.5 ml/min during a six-second interval; since this exceeds the limit listed at the bottom of Table 4-1, the change will appear as a step at TIME = 35.1 MIN.

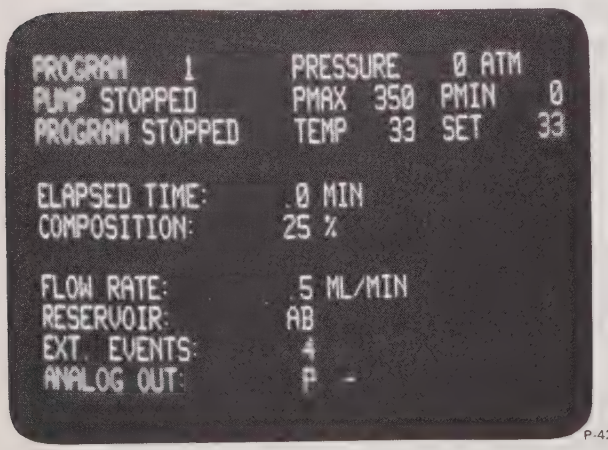
TIME + 45 + FLOW + 2 + ENTER

TIME + 50 + FLOW + .5 + ENTER

FIGURE 4-6 OPERATING PROGRAM—EXAMPLE 3
(a) Gradient-Elution Profile, (b) Keyboard Entries, (c) CRT Display for Program 1

TIME + 0 + % + 25 + ENTER	
TIME + 10 + % + 25 + ENTER	
TIME + 15 + % + 50 + ENTER	
TIME + 20 + % + 50 + ENTER	
TIME + 25 + % + 75 + ENTER	
TIME + 35 + % + 75 + ENTER	
TIME + 45 + % + 25 + ENTER	
TIME + 55 + PRGM + 1 + ENTER	This final time-programmed entry orders the program to restart after 55 minutes.
TIME + 0 + EVNT + 4 + ENTER	External event 3—see Table 4-2 for the external events code— will be activated at the beginning of the program; it will remain on until a subsequent command turns it off.
TIME + 50 + EVNT + 0 + ENTER	Turns off event 3 after 50 minutes.
DSPL	This command sorts the entries in the program listing in chronological order; if this command were not given, the listing would be sorted automatically when the **START** key was depressed.
TEMP + 33 + ENTER	Sets the temperature controller to 33°C.
PMAX + . . + ENTER	Changes the ANALOG OUT signal to column-head pressure.
TIME + 0 + PRGM + 2 + ENTER	
TIME + 0 + PRGM + DEL (DELETE PROGRAM? displayed) + **ENTER**	
TIME + 0 + FLOW + .5 + ENTER **TIME + 0 + % + 25 + ENTER** **TEMP + 33 + ENTER** **PMAX + . . + ENTER**	These four entries match the initial conditions of program 1, except that no external events are activated.
TIME + .5 + PRGM + 1 + ENTER	After 30 seconds program 1 will begin.

(c)



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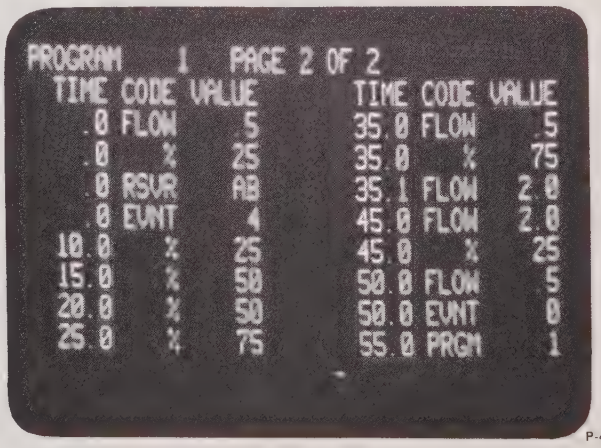

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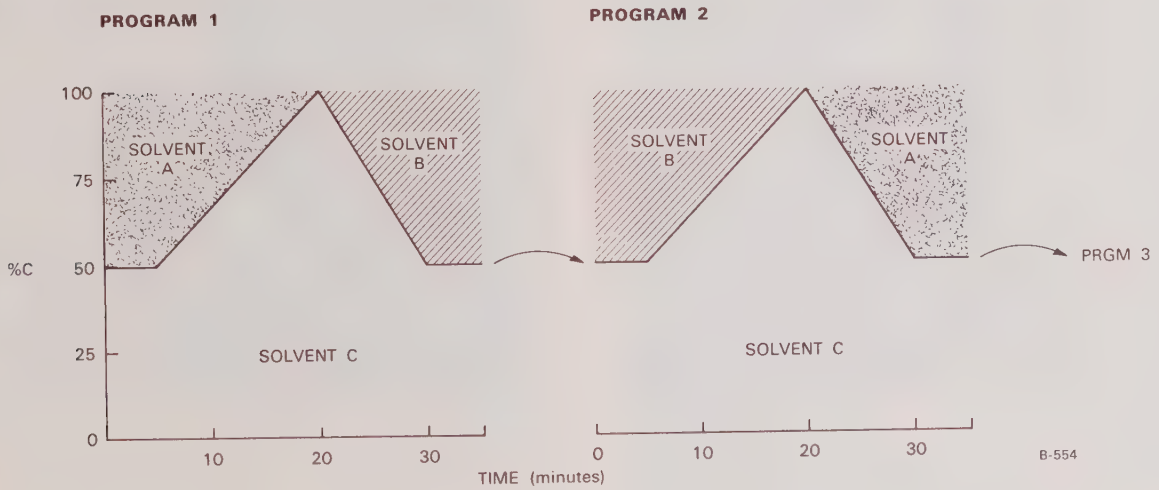
FIGURE 4-6 OPERATING PROGRAM—EXAMPLE 3
(a) Gradient-Elution Profile, (b) Keyboard Entries, (c) CRT Display for Program 1 (Cont.)

The final example assumes that a Model 8050 AutoSampler (but no CDS 111) is installed on the Model ...00 LC, as described in paragraph 2.7.2. Each time the AutoSampler receives a PROGRAM COMPLETE message from the Model 5000, or whenever event 1 is activated, the AutoSampler begins a purge/sampling cycle, then after about 75 seconds injects a new sample and restarts the current program. If no samples remain, the AutoSampler stops the pump. More details on operating the AutoSampler with the Model 5000 appear in paragraph 4.4.

- Example 4—Linked Programs. This example links two programs, each of which uses a different pair of solvents. The second of the programs then links to a third, which is not part of the example. This allows a series of different programs to be run on different aliquots of the same sample or on different samples. Each of the programs in the example has two important features: it generates the initial conditions of the following program, and it activates external event 1—for only six seconds—1.2 minutes (72 seconds) before linking to the next program. Event 1 initiates the purge/sampling cycle of the AutoSampler. A few seconds after the next program begins, the AutoSampler completes the 75-second purge/sampling cycle, injects a new sample, then resets and restarts the new program. Figure 4-7 illustrates the elution profiles, entries, and listings for programs 1 and 2.

(a)



(b)

TIME + 0 + PRGM + 1 + ENTER

TIME + 0 + PRGM + DEL

(DELETE PROGRAM? displayed) + **ENTER**

TIME + 0 + FLOW + 1 + ENTER

RSVR + 1 + 3 + ENTER

% + 50 + ENTER

These two entries are examples of the flexibility permitted when making entries: the processor assumes TIME = .0 MIN since that was the last time value specified.

TIME + 5 + ENTER

Here the processor assumes % = 50.

TIME + 20 + % + 100 + ENTER

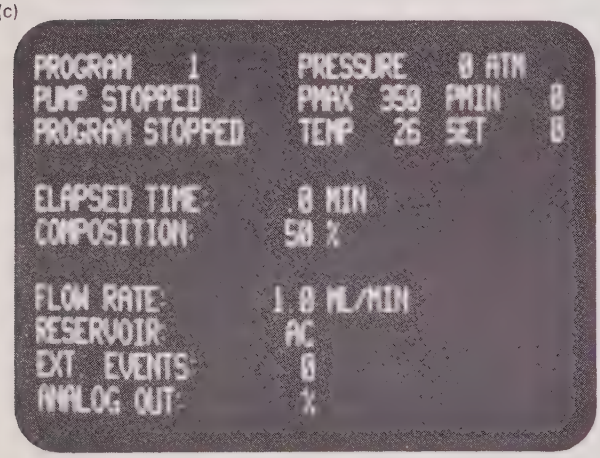
RSVR + 2 + 3 + ENTER

After 20 minutes the pair of reservoirs from which solvent is being drawn will switch from A & C to B & C (see Figure 3-1).

FIGURE 4-7 OPERATING PROGRAM—EXAMPLE 4
(a) Gradient-Elution Profiles, (b) Keyboard Entries, (c) CRT Displays

TIME + 30 + % + 50 + ENTER	
TIME + 33.8 + EVNT + 1 + ENTER **TIME + 33.9 + EVNT + 0 + ENTER**	These two entries activate event 1 (a contact closure) for six seconds. The purge/sampling cycle of the AutoSampler thus begins 1.2 minutes before the end of program 1.
TIME + 35 + PRGM + 2 + ENTER	This final time-programmed entry orders a switch to program 2.
TIME + 0 + PRGM + 1.2 + ENTER (MOVE PROGRAM? displayed) + **ENTER**	Duplicates program 1 into program 2, leaving program 1 intact and displaying program 2.
TIME + 0 + RSVR + 2 + 3 + ENTER	
TIME + 20 + RSVR + 1 + 3 + ENTER **TIME + 35 + PRGM + 3 + ENTER**	Program 2 now contains conflicting entries for these two times and parameters.
DSPL	Deletes the earlier of conflicting entries.

(c)



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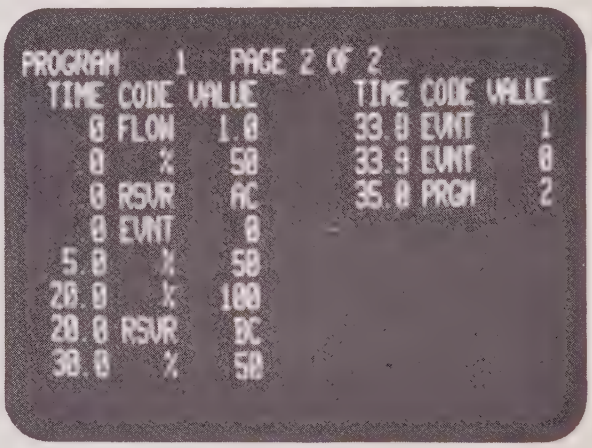

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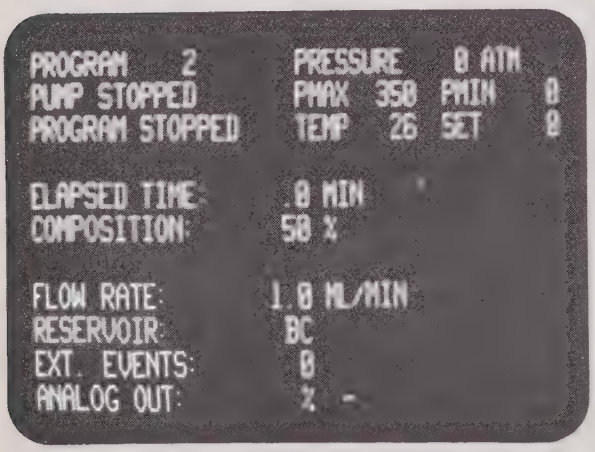

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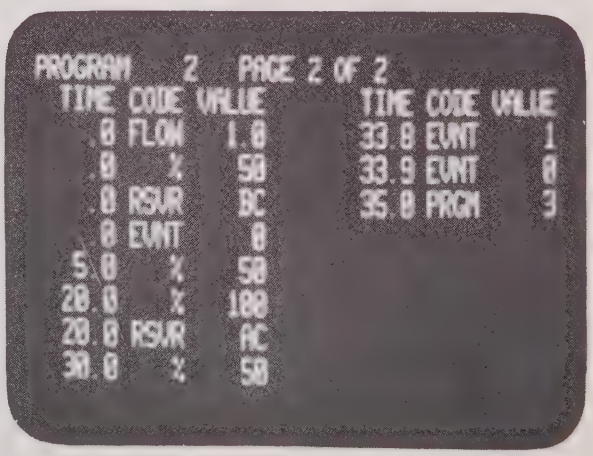

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FIGURE 4-7 OPERATING PROGRAM—EXAMPLE 4
(a) Gradient-Elution Profiles, (b) Keyboard Entries, (c) CRT Displays (Cont.)

4.3 ROUTINE OPERATION

This paragraph describes the operating procedures and precautions applicable to all chromatography systems that include a Model 5000. It also includes instructions for making an injection with the two manual injectors. The additional steps necessary for the operation of systems that include an AutoSampler or a CDS 111 are summarized briefly in paragraph 4.4. The following instructions also assume that the Model 5000 has been properly plumbed, that all electrical connections have been made, and that an appropriate program has been entered into memory.

CAUTION

Components made from stainless steel are subject to attack from halide salts and strong oxidizing agents (including aqueous solutions of manganese, chromium, nickel, copper, iron, and molybdenum). Such solutions should be avoided as mobile phases. If corrosive salts must be used, the corrosion resistance of the stainless-steel components can be improved by passivating them with nitric acid.

Also, cyclohexane should be avoided as a solvent since it freezes under high pressure, even at room temperature.

Finally, make sure that an adequate waste container is provided during routine operation. The detector exit, the purge exit of the injector, and the waste exit of the loop valve (if installed) must all be routed to an appropriate container to avoid solvent spills.

4.3.1 Changing Solvents

If you are changing solvents it is necessary to purge the system of the old solvent and to reequilibrate the column with the new solvent. If the old and new solvent mixtures are miscible, the following instructions (Paragraph 4.3.2 and 4.3.3) provide adequate insurance that the system is reequilibrated with the new solvent. If the old and new solvents are immiscible, however, it may be necessary to purge the entire system with a series of solvents. For example, when changing from a water/methanol mixture to a hexane/methylene chloride mixture, all hydraulic components, including both solvent inlet lines, should be thoroughly purged (see paragraph 4.3.3) with isopropanol, then with methylene chloride. If it is necessary to take a similar precaution with the detector, it should be disconnected from the system and purged separately.

4.3.2 Priming the Pump

If the instrument is in continuous use, the pump should never lose prime; however, if the solvent reservoir is changed or if the pump has been stopped for a prolonged period, it may be necessary to prime it before beginning an analysis.

(1) Fill the solvent reservoirs with the solvents to be used. With the variable-backpressure restrictor installed downstream of the detector, it is usually unnecessary to degas the solvents. Nonetheless degassing is often a useful precaution. A 10-μ particulate filter (see paragraph 2.3.2) should be at the inlet end of each solvent line. Recap each reservoir.

(2) As shown in Figure 4-8, open the bleed valve on the front of the pump by turning it counterclockwise one-half to one full turn until the tip points downward. Place a small beaker beneath the valve exit to catch the effluent.

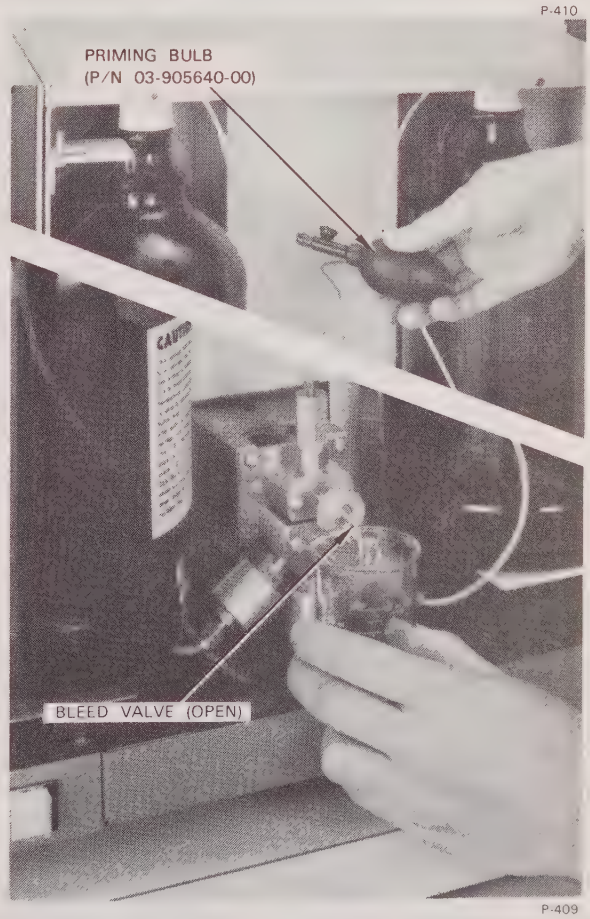


FIGURE 4-8 PRIMING THE PUMP

(3) If two solvents are used, ensure that the correct reservoirs have been selected in the program, then set the initial solvent composition to 0%. If only a single solvent reservoir is used, set the solvent composition to 100%.

(4) Attach the priming bulb (P/N 03-905640-00, supplied in the standard accessory kit) to the cap of the first reservoir as shown in Figure 4-8.

(5) Push **PURGE**, then pressurize the solvent reservoir by squeezing the priming bulb. (With the optional 1000-ml Erlenmeyer flasks it may be necessary to hold the reservoir cap in place so that it seals securely.) When solvent begins to flow freely from the bleed valve with each pump stroke, stop the pump by pushing **STOP**.

(6) If two solvent reservoirs are being used, set the initial solvent composition to 100%, then repeat steps (4) and (5) for the second reservoir.

(7) Close the bleed valve.

4.3.3 Purging the System

The following steps purge the components of the system upstream of the injector with the new solvent mixture.

(1) Enter the appropriate initial composition for the program to be run.

(2) After making sure that the purge exit drains into a waste container, open the purge vent of the injector:

- by opening the purge valve fully (as shown in Figure 4-9), if either of the loop injectors is installed

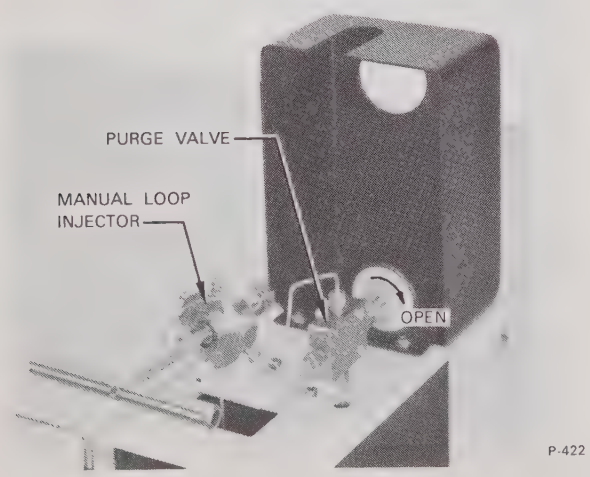


FIGURE 4-9 OPENING THE PURGE VALVE OF THE MANUAL LOOP INJECTOR

- by turning the stop-flow injector plug to the purge position (1/4-turn counterclockwise from the fully tightened position)

(3) Push **PURGE** and allow the pump to run for 1-3 minutes; this will purge the hydraulic components upstream of the injector with 10-30 ml of the initial solvent mixture. Press **STOP** and close the purge exit.

(4) Ensure that the correct initial flow rate has been set, then press **PUMP**. Allow the entire system to stabilize at the initial conditions of the program.

4.3.4 Making an Injection

● Stop-Flow Injector

To make an injection using the stop-flow injector:

(1) Push the **STOP** key and wait a few seconds until the column-head pressure (as displayed on the CRT screen) drops to atmospheric pressure.

(2) Remove the injector plug, then insert the syringe needle in the injection port. The needle should penetrate until the syringe barrel touches the body of the injector. Make the injection and remove the syringe.

(3) Replace the injector plug, tightening it snugly. Press the **START** key, starting the pump and the program.

● Manual Loop Injector

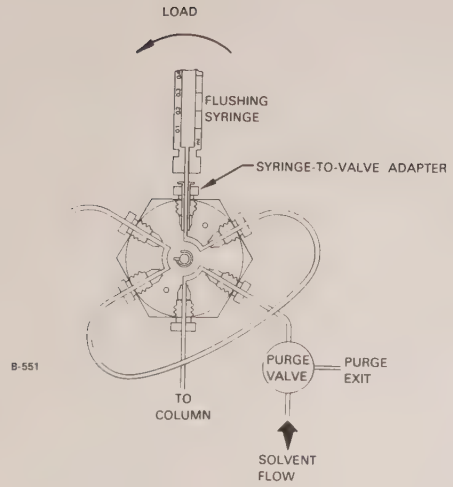
The instructions given in Figure 4-10 pertain to high-pressure loop injectors that have been installed exactly as described in paragraph 2.8.1. Note especially the orientation of the sample loop and the cutout in the valve collar. Figure 4-10 includes two sets of instructions, one for injecting a full loop of sample (the standard loop volume is 10 µl) and a second for injecting less than 10 µl of sample. The drawings in the figure depict the second method, which requires the optional, specially calibrated sample syringe (P/N 89-988825-00) and syringe-to-valve adapter (P/N 89-988826-00).

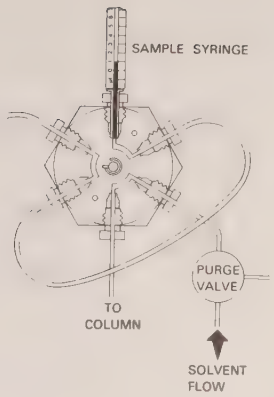
CAUTION

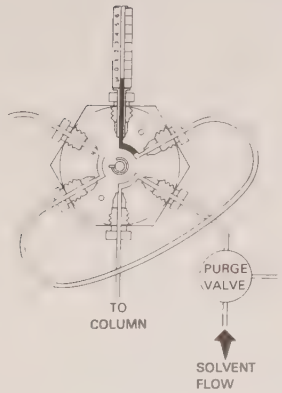
Only square-ended flushing and sample syringes should be inserted into the loop injector. Standard syringes can penetrate into the valve core, scratching the sealing surfaces.

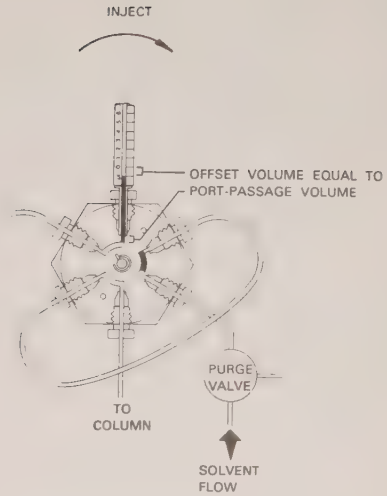
4.3.5 Standby Conditions

When the instrument is not being used, it is usually safe to turn off the main power switch. Line power will continue to charge the RAM battery, hence all programs will be saved, regardless of how long the instrument is left off. However, if aqueous buffers









TO INJECT LESS THAN 10 µl

(a) FLUSH SAMPLE LOOP. With the pump running, turn the valve handle to the LOAD (fully counterclockwise) position, then insert a ***square-ended*** flushing syringe into the syringe-to-valve adapter until the needle bottoms out against the valve body. Tighten the knurled nut on the adapter finger-tight. Flush the sample loop with solvent. Continue to depress the syringe plunger while removing it from the adapter. This will ensure that the flow path is completely filled with solvent.

(b) INSERT SAMPLE SYRINGE. Insert the sample syringe until the needle bottoms out against the valve body.

(c) LOAD SAMPLE. Depress the syringe plunger fully.

(d) INJECT SAMPLE. Turn the valve handle to the INJECT (fully clockwise) position, placing the sample into the solvent stream and injecting it onto the column. (Note that the sample syringe has been calibrated to compensate for the volume of sample in the port passage, which is not swept onto the column.) Simultaneously press the **START** key, starting the program

FOR FULL-LOOP INJECTION

(a) FLUSH SAMPLE LOOP. With the pump running turn the valve handle to the LOAD (fully counterclockwise) position, then flush the sample loop thoroughly with solvent. The sample inlet will usually be plumbed with a length of stainless-steel tubing, through which solvent and sample can be introduced

(b) LOAD SAMPLE. Fill the sample loop completely with sample.

(c) INJECT SAMPLE. Turn the valve handle to the INJECT (fully clockwise) position, placing the sample into the solvent stream and injecting it onto the column. Simultaneously, press the **START** key, starting the program

CAUTION

The valve should always be left in either the LOAD or INJECT position. If the valve remains in an intermediate position, high pressure in the system can damage the sealing surfaces.

FIGURE 4-10 INJECTING A SAMPLE WITH THE MANUAL LOOP INJECTOR

(especially those containing corrosive salts such as halides) are being used, the pump should be left running during standby periods. ***If these corrosive solutions are left immobile in the system, they can significantly reduce the life of stainless-steel components.***

4.4 AUTOMATED SYSTEM OPERATION

This paragraph summarizes the most important points that should be observed when the Model 5000 is used with a Model 8050 AutoSampler, a CDS 111C chromatography data system, or an automatic loop injector. If a CDS 111L is installed as shown in Figure 2-12, you should refer to the applicable addendum to the CDS 111C manual (Publication No. 85-001142-00). For detailed instructions on operating the AutoSampler and the CDS 111C, see the respective manuals.

4.4.1 Using the AutoSampler Alone

When the AutoSampler is installed as shown in Figure 2-11a, it allows a series of samples (or different aliquots of the same sample) to be analyzed, either by the same program or by a series of linked programs—see Example 4 in paragraph 4.2. In general,

(1) The controls on the front panel of the AutoSampler should be set as described in step (1), paragraph F.2.1, of the LC AutoSampler Addendum (Publication No. 85-001129-01), except that the INTERFACE GC/LC switch must be engaged. The AutoSampler should be in the RUN MULTIPLE mode.

(2) The essential features of the operating program(s) depend on whether a single program is being used, or a series of linked programs is being employed.

If a single program is being used:

- The program must regenerate its initial conditions, and it must ***not*** link either with another program or with itself. The AutoSampler will restart the program when a new injection is made.
- Event 1 should not be used during the program. (If event 1 must be used, the cable connected to the EVENT 1 outlet must be unplugged.)

If linked programs are being used:

- Each program must generate the initial conditions of the following program.
- Each program must activate event 1 exactly 1.2 minutes before it links to the following program. This initiates the 75-second purge/sampling cycle in the AutoSampler.

(3) The analysis sequence is begun by establishing stable initial conditions in the Model 5000, then pushing **PUMP** (though the pump will already be running). The AutoSampler will then begin a purge/sampling cycle, inject the first sample, and start the program selected at the Model 5000. Another purge/sampling cycle, culminating in the injection of the second sample, will begin when the AutoSampler receives a PROGRAM COMPLETE signal from the Model 5000 ***or*** when event 1 is activated. Whenever an injection is made, the AutoSampler resets and starts the current program. The AutoSampler stops the pump when no samples remain.

4.4.2 Using the AutoSampler and the CDS 111C

When both an AutoSampler and a CDS 111C are installed as shown in Figure 2-11b, a series of samples (or different aliquots of the same sample) can be analyzed, either by the same program or by a series of linked programs. In general,

(1) The controls on the front panel of the AutoSampler should be set as described in step (3), paragraph F.3.1, of the LC AutoSampler Addendum (Publication No. 85-001129-01), except that the INTERFACE GC/LC, SAMPLE VOL RMT, and INJ/VIAL RMT switches must be engated. The AutoSampler should be in the RUN MULTIPLE mode.

(2) The essential features of the operating program(s) depend on whether a single program is being used, or a series of linked programs is being employed.

If a single program is being used:

- The program must regenerate its initial conditions, and it must ***not*** link either with another program or with itself. The AutoSampler will restart the program when a new injection is made.
- Event 1 should not be used during the program. (If event 1 must be used, the cable connected to the EVENT 1 outlet must be unplugged.)

If linked programs are being used:

- Each program must generate the initial conditions of the following program.

- Each program must activate event 1 (for six seconds) at least three minutes before it links to the following program. The CDS 111C will respond to this contact closure by loading a file and beginning to monitor the baseline. (If the initial peak width in section 1 of the CDS 111C file is set to a value greater than 63 seconds, the first event 1 must be activated at least 4.7 minutes before the program link.)
- Each program must activate event 1 a second time exactly 1.2 minutes before it links to the following program. The CDS 111C should by now be in READY, and the AutoSampler will begin its 75-second purge/sampling cycle.

(3) The stop time in section 1 of the CDS 111C file(s) must be short enough to allow the CDS 111C to return to MONITOR well before the end of the respective program(s) being run on the Model 5000. The CDS 111C must have completed its computations before it is ordered to begin a subsequent monitor period. The CDS 111C must be in the AUTO mode, and for the beginning of the analysis sequence should be in STANDBY.

(4) The analysis sequence is begun by establishing stable initial conditions in the Model 5000, then pushing START at the CDS 111C, followed by **PUMP** at the Model 5000 (though the pump should already be running). This loads the first file and initiates the first monitor period of the CDS 111C. After the CDS 111C goes to READY, pressing **PUMP** a second time will begin the purge/sampling cycle at the AutoSampler. The AutoSampler will then inject the first sample and start the program selected at the Model 5000. Subsequently, when the AutoSampler receives a PROGRAM COMPLETE signal, it orders the CDS 111C to begin another monitor period. When the CDS 111C is ready, the AutoSampler begins a purge/sampling cycle (which culminates in another sample injection), then restarts the program currently displayed on the CRT. A similar sequence of events follows the activation of event 1. If event 1 is activated for six seconds, the AutoSampler orders the CDS 111C to begin a monitor period, but it does not respond immediately when the CDS 111C goes to READY. Instead, it awaits a second event 1 before beginning its 75-second purge/sampling cycle. The AutoSampler stops the pump when no samples remain.

4.4.3 Using the Automatic Loop Injector

Example 3 in paragraph 4.2 illustrates the use of the automatic loop injector in an on-line analysis system. In that example event 3 was used to actuate the valve, thus injecting a sample. In general,

(1) A single operating program can be used, and linked to itself, or several programs can be linked sequentially. In either case, each program should generate the initial conditions of the program that follows.

(2) Samples should be injected by using external event 3 to actuate the automatic valve at TIME = .0 MIN in each program. The external event should then be turned off well before the end of the program.

(3) Unless an equilibration program is used as illustrated in Example 3 of paragraph 4.2, the first run will yield nonreproducible results, since a sample will be injected when the program is first displayed on the CRT screen, even though the program has not begun.

This summary briefly outlines the routine procedures that must be followed to program and operate the Model 5000. For ready reference it can be removed from the manual and kept near the instrument. The other side of this sheet summarizes the formats for keyboard entries.

OPERATING SUMMARY

- If necessary display and clear a new program:

  [TIME] + [0] + [PRGM] + *program #* + [ENTER]

  [PRGM] + [DEL] + [ENTER]

- Enter values for PMAX, PMIN, and column temperature:

  [P MAX] + *value* + [ENTER]

  [P MIN] + *value* + [ENTER]

  [TEMP] + *value* + [ENTER]

- Enter initial values for flow rate and solvent composition:

  [TIME] + [0] + [FLOW] + *flow rate* + [ENTER]

  [%] + *composition* + [ENTER]

- Select the correct reservoirs (See Figure 3-1):

  [TIME] + [0] + [RSVR] + *reservoir(s)* + [ENTER]

- If necessary change the ANALOG OUT signal and enter the appropriate external events.

- If you are using a gradient-elution or flow program, create the program by entering the appropriate flow rate and composition values at the endpoints of each linear segment in the program. You will often want to reestablish the initial conditions at the end of the program.

- Purge the system of any old solvent, then fill the appropriate solvent reservoirs and prime the pump if necessary.

- Start the pump, then allow the system to stabilize at the initial conditions of the program.

- If the other components of the system (detector, recorder, etc.) are ready, make an injection and start the program.

SUMMARY OF ENTRY FORMATS

- Entering PMAX, PMIN, SET (TEMP key)

  parameter key + *new value* + [ENTER]

- Entering Time-Programmable Parameters

  [TIME] + *time value* + *parameter key* + *parameter value* + [ENTER]

- Selecting ANALOG OUT

  [TIME] + *any legal value* + [FLOW] or [%] + [•] + [•] + [ENTER]

  or

  [P MAX] or [P MIN] + [•] + [•] + [ENTER]

- Displaying a New Program

  [TIME] + *elapsed time or zero* + [PRGM] + *new program number* + [ENTER]

- Deleting a Program

  [TIME] + [0] + [PRGM] + [DEL] (display will show DELETE PROGRAM?) + [ENTER] (any other key will abort the delete command and clear the entry field)

- Duplicating a Program

  [TIME] + *any legal value* + [PRGM] + *program number to be duplicated* + [•] + *new program number* + [ENTER] (display will show MOVE PROGRAM?) + [ENTER] (any other command will abort the move command and clear the entry field)

- Deleting a Time-Programmed Entry

  [TIME] + *time of entry to be deleted* + *parameter to be deleted* + [DEL]

This summary briefly outlines the routine procedures that must be followed to program and operate the Model 5000. For ready reference it can be removed from the manual and kept near the instrument. The other side of this sheet summarizes the formats for keyboard entries.

OPERATING SUMMARY

- If necessary display and clear a new program:

  [TIME] + [0] + [PRGM] + *program #* + [ENTER]

  [PRGM] + [DEL] + [ENTER]

- Enter values for PMAX, PMIN, and column temperature:

  [P MAX] + *value* + [ENTER]

  [P MIN] + *value* + [ENTER]

  [TEMP] + *value* + [ENTER]

- Enter initial values for flow rate and solvent composition:

  [TIME] + [0] + [FLOW] + *flow rate* + [ENTER]

  [%] + *composition* + [ENTER]

- Select the correct reservoirs (See Figure 3-1):

  [TIME] + [0] + [RSVR] + *reservoir(s)* + [ENTER]

- If necessary change the ANALOG OUT signal and enter the appropriate external events.

- If you are using a gradient-elution or flow program, create the program by entering the appropriate flow rate and composition values at the endpoints of each linear segment in the program. You will often want to reestablish the initial conditions at the end of the program.

- Purge the system of any old solvent, then fill the appropriate solvent reservoirs and prime the pump if necessary.

- Start the pump, then allow the system to stabilize at the initial conditions of the program.

- If the other components of the system (detector, recorder, etc.) are ready, make an injection and start the program.

SUMMARY OF ENTRY FORMATS

- Entering PMAX, PMIN, SET (**TEMP** key)

  parameter key + *new value* + [ENTER]

- Entering Time-Programmable Parameters

  [TIME] + *time value* + *parameter key* + *parameter value* + [ENTER]

- Selecting ANALOG OUT

  [TIME] + *any legal value* + [FLOW] or [%] + [•] + [•] + [ENTER]

  or

  [P MAX] or [P MIN] + [•] + [•] + [ENTER]

- Displaying a New Program

  [TIME] + *elapsed time or zero* + [PRGM] + *new program number* + [ENTER]

- Deleting a Program

  [TIME] + [0] + [PRGM] + [DEL] (display will show DELETE PROGRAM?) + [ENTER] (any other key will abort the delete command and clear the entry field)

- Duplicating a Program

  [TIME] + *any legal value* + [PRGM] + *program number to be duplicated* + [•] + *new program number* + [ENTER] (display will show MOVE PROGRAM?) + [ENTER] (any other command will abort the move command and clear the entry field)

- Deleting a Time-Programmed Entry

  [TIME] + *time of entry to be deleted* + *parameter to be deleted* + [DEL]

SECTION 5
MAINTENANCE AND SERVICE

5.1 INTRODUCTION

Except for paragraph 5.2 on routine maintenance this section deals with procedures you should expect to follow only when your instrument needs repair. This should be an infrequent occurrence, but you can expect some of the wetted components, especially in the pump, to wear during the life of the instrument. Before replacing any part you should use the troubleshooting guide in paragraph 5.3 to isolate the source of the problem. As an additional aid each repair procedure is prefaced with the symptoms the procedure is aimed at eliminating.

The hydraulic-system components described in paragraph 5.4 are designed so that they can be easily replaced by the customer, and replacement parts are included in the standard accessory kit. Paragraph 5.5 describes additional repair and parts-replacement procedures that should rarely be necessary, but that are easy enough for most customers to undertake. For additional parts or assistance in servicing the instrument, contact your nearest Varian district office.

NOTE

Several of the procedures in the following paragraphs include torque specifications for replacing nuts and fittings. For customers without access to torque wrenches, the following guidelines should be adequate.

- **In general, nuts should be tightened only enough to prevent leaks. Nuts can therefore be made tight enough to seat the components of the fitting, then tightened further only if leaks appear.**
- **The torque specifications can serve as useful guides if you keep in mind that 12 in.-lb is equivalent to a pound of force on a 12-inch wrench (or two pounds on a six-inch wrench). Most fittings require less than 35 in.-lb of torque.**

5.2 ROUTINE MAINTENANCE

The only routine maintenance necessary for the Model 5000 is ***monthly*** lubrication of the pump. The oil wick (in the top of the pump casting) and the felt sleeve that surrounds the Belleville washers (Figure 5-1) should be saturated with lubricating oil (P/N 88-799450-00, supplied in the accessory kit) once each month. This supplies lubrication to the washers and to the piston slider and inlet-valve slider.

CAUTION

Failure to perform this routine lubrication may cause serious damage to the pump. Such damage is not covered under the Varian Warranty.

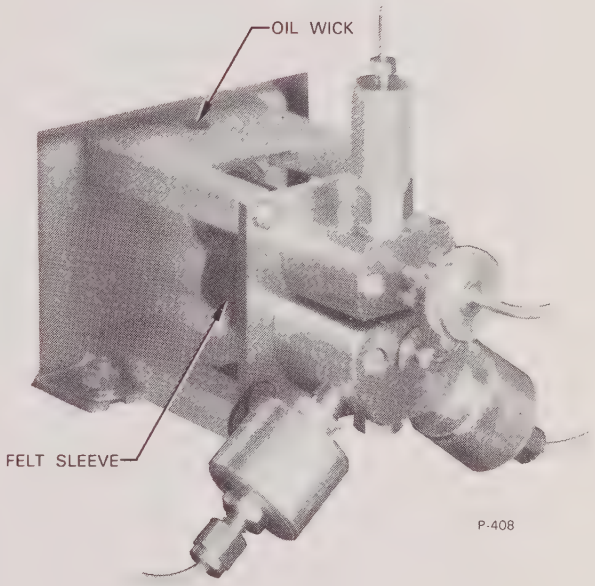


FIGURE 5-1 LUBRICATING THE PUMP

5.3 TROUBLESHOOTING

The troubleshooting chart that appears as Table 5-1 is organized as a flow diagram so that system problems can be more easily isolated. The chart does ***not*** contain references to problems that can be traced to degraded or inappropriate columns, or to chemistry in general. The table does discuss symptoms for a system that includes a 254/280-nm UV Detector, and in many cases the same symptoms arise with other detectors. All references in the table are to sections or paragraphs (#) in this manual, except where the UV Detector manual is specified.

Before using the troubleshooting chart, check obvious sources of problems, such as the main power switch, the UV Detector power switch, the keyboard lock-out switch, and the fuses listed in Table 2-1. To use the chart select the symptom description that best describes your problem, then consider each possible cause, which are marked with targets (●), in the order listed. Statements preceded by a circled letter and number represent branches in the flow chart; statements with the same letter (for example, A1, A2, and A3) should be considered as mutually exclusive alternatives. However, if one branch of the chart does not solve the problem, back up and consider the others. If a problem persists call the nearest Varian district office.

TABLE 5-1
TROUBLESHOOTING GUIDE

PUMP WILL NOT PRIME OR IS DIFFICULT TO PRIME

- *bleed valve closed*
- *solvent level too low*
- *incorrect reservoir selected*
- *air trapped in 10-μ particulate filter*

  When the filter is removed from a volatile solvent, bubbles can form in the interstices of the porous metal. When the filter is returned to the solvent, it is sometimes difficult to prime the pump. Remove the bubbles in an ultrasonic bath, and keep filters stored under solvent.

If the symptoms are caused by none of the above problems, remove the solvent line from the proportioning valve. Try to force solvent through the solvent line by squeezing the priming bulb.

(A1) Solvent flows freely through the line.

- *tubing pinched at proportioning-valve inlet*

  Remake the connection between the solvent line and the valve, observing the precautions in #2.3.2.

- *fuse F11 blown*

If the connection and the fuse are okay, the problem is probably a faulty proportioning valve. Determine whether the coil is operating correctly by switching coils with another valve.

(B1) The coil is okay.

- *sticky poppet valve*

  see #5.4.2 under **Cleaning the Poppet Assembly.**

(B2) The coil is faulty.

- *defective coil*

  See #5.5.1

- *electronics problem*

  Call the nearest Varian district office.

(A2) Solvent does not flow or flows with difficulty.

- *tubing pinched at filter*

  Remake the connection between the tubing and the filter, observing the precautions in #2.3.2.

- *plugged filter*

  Replace the filter as described in #2.3.2.

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

PUMP LOSES PRIME

- *solvent level too low*
- *gas dissolved in solvent*

  When using volatile solvents at low flow rates, it is sometimes necessary to degas the solvent.

If the symptoms are caused by neither of the above, remove the solvent line from the proportioning valve. Try to force solvent through the solvent line by squeezing the priming bulb. Then consider alternatives **A1** and **A2** under **PUMP WILL NOT PRIME OR IS DIFFICULT TO PRIME** above.

PUMP STOPS OR STALLS

(A1) Pump stalls: CRT shows PUMP RUNNING and pump tries to pump against excessive backpressure.

- *flow rate exceeds specifications*

  Check specifications in Section 1.

If the flow rate is within specifications, check the regulated backpressure through the flow controller as described in #5.5.3.

(B1) The backpressure exceeds 5000 psi.

- *flow controller obstructed or (more likely) misadjusted*

  Readjust the flow controller; if necessary replace the seal and needle seat (#5.4.5).

(B2) The backpressure is below 5000 psi.

- *plugged frit in check-valve assembly*

  See #5.4.4.

- *other obstruction upstream of pressure transducer*

  It may be necessary to check each section of tubing separately for internal obstructions. A cleaning procedure for stainless-steel tubing is included in #2.9.6. First, however, check for obvious crimps and twists.

(A2) Pump stops: CRT shows PUMP RUNNING.

- *flow rate set to 0.0 ml/min*
- *fuse F9 blown*

  See #2.5.

(A3) Pump stops: CRT shows PUMP STOPPED.

(B1) Pressure limit (PMAX) has been exceeded.

- *PMAX set too low*
- *loop injector partially actuated*

  The loop injector must always be in either the LOAD or INJECT position.

- *backpressure restrictor misadjusted or plugged*

  The backpressure restrictor is at fault if the problem disappears when it is disconnected. See #2.11

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

- *obstructed column or detector*

  The detector is at fault if the problem disappears when it is disconnected from the column exit. Clean the detector as described in #5.2 of the UV Detector manual. If the problem disappears only when the column is removed, replace it. Check also for other crimps or obstructions downstream of the pressure transducer.

- *flow rate too high for column and solvent being used*

(B2) Pressure has dropped below the low-pressure limit (PMIN).

- *PMIN set too high*

- *pump has lost prime*

  See remedies under **PUMP LOSES PRIME** above.

- *system leaks*

  Leaks serious enough to cause a drastic loss of pressure will usually be visible. Check also to ensure that solvent is not being pumped out the purge vent of the injector.

TEMPERATURE CONTROLLER UNRESPONSIVE

- *fuse F3 or F4 blown*

  See #2.5

- *temperature-limit switch incorrectly set*

  If the column temperature exceeds the limit set on this switch, the temperature controller will shut down. It can be reactivated only by turning the instrument off, then on. To change the temperature limit see #2.9.5.

REPEATED POWER-LOSS MESSAGES APPEAR ON CRT

- *line voltage too low*

  See #2.4 for a procedure for rewiring the instrument to more nearly match the prevailing line voltage.

KEYBOARD UNRESPONSIVE

- *lock-out switch engaged*

  CRT will display RMT after the program number.

- *software execution error*

  It may be necessary to turn the instrument off, then on, to regain use of the keyboard.

NO SAMPLE PEAKS (BASELINE IS OKAY)

- *pump has lost prime*

  See remedies under **PUMP LOSES PRIME** above.

- *system leaks*

  Such serious leaks are usually visible (see **LEAKS ARE VISIBLE** below). Check also to ensure that solvent is not being pumped out the purge vent of the injector.

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

RECORDER WILL NOT ZERO OR IS DIFFICULT TO ZERO

(A1) UV lamp is not lit.

- ***fuse F13 blown***

  Replace the fuse (see Figure 3-2 in the UV Detector manual).

- ***bad connection at interconnect-cable socket in column enclosure or at detector controller***

  Check connections as described in Section 2 of the UV Detector manual.

- ***defective lamp starter***

  See #5.4.1 in the UV Detector manual.

- ***defective lamp***

  See #5.4.2 in the UV Detector manual.

(A2) UV lamp is okay.

(B1) Problem persists when RANGE switch is set to SHORT.

- ***bad electrical connections***

  Check connections and compare them to Figure 2-10.

- ***recorder problem***

(B2) Problem disappears when RANGE switch is set to SHORT.

- ***bubble in flow cell***

  The bubble can sometimes be flushed from the flow cell by pumping at a higher flow rate for a few minutes. If not, the detector must be disconnected and flushed. If the problem reappears repeatedly, check for sources of air in the solvent under **BASELINE IS NOISY OR SHOWS SPIKES** below.

- ***bad electrical connections***

  Check recorder connections (Figure 2-10) and connections to the optical module and detector controller (Section 2 of the UV Detector manual).

- ***beam attenuator misadjusted***

  See #5.1 in the UV Detector manual.

- ***gasket blocking detector light path*** or

- ***contaminated flow cells*** or

- ***leaky cell-holder gasket***

  These last three problems can be corrected by cleaning and reassembling the cell holder as described in #5.2 of the UV Detector manual.

- ***deteriorating UV lamp***

  See #5.4.2 in the UV Detector manual.

BASELINE IS NOISY OR SHOWS SPIKES

These symptoms are usually caused by bubbles in the solvent stream, though sometimes a detector problem is at fault. Determine whether the problem is independent of the reservoir chosen by selecting each separately.

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

(A1) The problem can be isolated to one solvent line.

- *gas dissolved in solvent*

  When using volatile solvents at low flow rates, it is sometimes necessary to degas the solvents.

- *clogged 10-μ particulate filter*

If neither of these is the problem, the proportioning valve may be faulty. Determine whether the coil is operating correctly by switching coils with another valve.

(B1) The coil is okay.

- *leak at inlet-valve head*

  See #5.4.2 under **Correcting Leaks.**

- *sticky valve poppet*

  See #5.4.2 under **Cleaning the Poppet Assembly.**

(B2) The coil is faulty.

- *defective coil*

  See #5.5.1.

- *electronics problem*

  Call the nearest Varian district office.

(A2) The problem cannot be isolated to one solvent line.

- *gas dissolved in solvent*

  When using volatile solvents at low flow rates, it is sometimes necessary to degas the solvent.

- *misadjusted backpressure restrictor*

  See #2.11.

- *contaminated flow cells*

  See #5.2 in the UV Detector manual.

- *dirty 280-nm phosphor*

  Clean the surface of the phosphor with a clean, lint-free cloth dampened with alcohol (see Section 4 of the UV Detector manual).

- *leaky inlet-valve seal*

  See #5.4.3 under **Replacing the Inlet-Valve Seat and O-ring, and the Inlet-Valve Seal and Bushings.**

- *defective UV lamp*

  See #5.4.2 in the UV Detector manual.

BASELINE DRIFTS

- *unstable temperature*

  Long-term baseline drift can be caused by fluctuations in the ambient temperature.

- *leaky cell-holder gasket* or

- *contaminated flow cells*

  Both of these problems can be corrected by cleaning the cell holder as described in #5.2 of the UV Detector manual.

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

- *defective UV lamp*

  See #5.4.2 in the UV Detector manual.

BASELINE "STAIRSTEPS" OR SIGNAL DOES NOT RETURN TO ZERO

- *loose connections or ground loops*

  Check connections and compare them to Figures 2-10, 2-11, 2-12, and 2-20.

- *ac feedback*

- *leaky cell-holder gasket*

  See #5.2 in the UV Detector manual.

PEAKS HAVE WRONG POLARITY

- *photocell assembly backwards*

  To reverse the photocell assembly, see Section 4 in the UV Detector manual.

SENSITIVITY POOR OR RESPONSE NONLINEAR

- *RANGE switch out of calibration*

  See #5.3 in the UV Detector manual.

- *254/280-nm switch incorrectly set or wrong photocell assembly installed*

  See Section 4 in the UV Detector manual.

- *sample or solvent absorbance too high*

  Change solvent or dilute sample.

- *faulty photocell assembly*

LEAKS ARE VISIBLE

- *leaky bleed valve*

  See #5.5.2 under **Replacing the Bleed-Valve Needle Tip.**

- *leaky fittings*

  Remake the fittings, using new components if necessary.

- *leaky injector*

  See #5.4.6 (loop injector) or #5.5.4 (stop-flow injector).

- *leaky flow-controller seal*

  See #5.4.5 under **Replacing the Spring-Loaded Seal.**

- *leak at the inlet-valve port*

  See #5.4.2 under **Correcting Leaks.**

- *leaky piston seal*

  If this seal leaks, solvent will often appear on the rear of the head mounting plate or under the pump head. See #5.4.3 under **Replacing the Piston Seal and Back-up Washer.**

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

CHROMATOGRAMS NOT REPRODUCIBLE

(A1) Retention times are consistently longer than normal.

(B1) Pressure displayed on the CRT screen is about normal or higher than normal.

- *column temperature too low*

  Check the ambient temperature and the temperature controller. See **TEMPERATURE CONTROLLER UNRESPONSIVE** above.

(B2) Pressure is lower than normal.

(C1) Solvent leaks are visible. (See **LEAKS ARE VISIBLE** above.)

(C2) There are no visible leaks.

Determine whether the problem can be isolated to one solvent line by using each reservoir separately to run a chromatogram on a sample of several components. Use the same solvent or mixture of solvents in each reservoir.

(D1) The chromatograms are identical.

Remove the solvent line from one proportioning valve, then run the pump, drawing all solvent from a second valve.

(E1) Solvent appears at the inlet of the disconnected valve.

- *leaky inlet-valve seat*

  See #5.4.3 under **Replacing the Inlet-Valve Seat and O-ring, and the Inlet Valve Seal and Bushings.**

(E2) No solvent appears.

- *leaky piston seal*

  This leak, which sometimes produces solvent at the rear of the head mounting plate, often passes unnoticed, especially with volatile solvents. See #5.4.3 under **Replacing the Piston Seal and Back-up Washer.**

(D2) The chromatograms are different. (The proportioning valve giving the longer retention times is faulty.)

Determine whether the coil is operating correctly by switching coils on two valves and again running a pair of chromatograms.

(E1) The coil is okay.

- *sticky valve poppet*

  See #5.4.2 under **Cleaning the Poppet Assembly.**

(E2) The coil is faulty.

- *defective coil* or
- *electronics problem*

  These problems will usually manifest themselves in other ways—the pump will lose prime or bubbles will appear in the solvent stream. To replace the coil see #5.5.1.

TABLE 5-1
TROUBLESHOOTING GUIDE (Cont.)

(A2) Retention times are consistently shorter than normal.

(B1) Pressure displayed on the CRT screen is about normal or lower than normal.

- ***column temperature too high***

  Check the ambient temperature or the value set on the temperature controller.

(B2) Pressure is higher than normal.

- ***leaky flow-controller seat***

  See #5.4.5 under **Replacing the Needle Seat and O-ring.**

- ***flow-controller backpressure set too low***

  Check and readjust the backpressure as described in #5.5.3.

(A3) Retention times are erratic.

- ***unstable temperature***

  Fluctuations in the ambient temperature will produce erratic chromatograms. The column temperature should be controlled.

If the temperature is stable the problem is probably a faulty proportioning valve. Isolate the problem to one solvent line by using each reservoir separately to run several chromatograms on a sample of several components. The faulty valve should yield nonreproducible results. Then determine whether the coil is operating correctly by switching coils on two of the valves.

(B1) The coil is okay.

- ***sticky valve poppet***

  See #5.4.2. under **Cleaning the Poppet Assembly.**

(B2) The coil is faulty.

- ***defective coil*** or
- ***electronics problem***

  These problems will usually manifest themselves in other ways— the pump will lose prime or bubbles will appear in the solvent stream. To replace the coil see #5.5.1.

5.4 ROUTINE SERVICE

5.4.1 10-μ Solvent Filter

→ a clogged filter will introduce bubbles into the solvent stream or cause the pump to lose prime

To replace a solvent filter follow the procedure described in paragraph 2.3.2.

5.4.2 Proportioning Valve

- **Correcting Leaks**

  → leakage will produce bubbles in the solvent stream or solvent leaks at the pump inlet port

Leaks at the pump inlet port can usually be corrected by tightening the proportioning-valve assembly at the inlet-valve head. Tighten only the 1/2" nut nearest the inlet-valve head. It should not be tightened forcefully—not more than 30-34 in.-lb (see the NOTE in paragraph 5.1).

- **Cleaning the Poppet Assembly**

  → a clogged or sticky poppet assembly will produce bubbles in the solvent stream and can cause the pump to lose prime; proportioning will be inaccurate, thus producing nonreproducible chromatograms

Internal contamination of the proportioning valve can usually be removed by cleaning the parts of the valve in acetone. When the valve is reassembled, the O-ring and gold shim (both supplied in the accessory kit) must be replaced. Proceed as follows.

(1) Turn off the main power switch on the Model 5000.

CAUTION

To prevent the pump from being inadvertently turned on during the following steps, the instrument power should be turned off.

(2) Remove the solvent inlet line from the proportioning valve by loosening the compression fitting at the base of the assembly. (To service valve C, it will be necessary to remove the drip tray.)

(3) The following steps involve the parts shown in Figure 5-2. (If more than one valve is being cleaned, take care never to interchange the components from different valves.) First remove the coil and Teflon shim by removing the 1/2" hex nut at the base of the coil. The coil will remain attached to the instrument by the electrical leads that are routed inside the pump shroud.

(4) Carefully loosen the valve base using a 1/2" wrench. The remaining components shown in Figure 5-2 fit loosely inside the valve base, so care should be taken when it is removed from the inlet-valve head.

(5) Before separating the parts of the poppet assembly, ***notice whether there are one, two, or three gold shims between the head of the valve orifice and the valve base.*** Now carefully separate the parts shown in Figure 5-2, discarding the O-ring and the gold shim(s).

(6) Clean the valve orifice, the poppet/seal subassembly, spring, and valve base by soaking them in acetone, then in distilled water. If necessary remove any deposits with a clean, lint-free cloth. Finally, soak the parts again in acetone and dry them thoroughly.

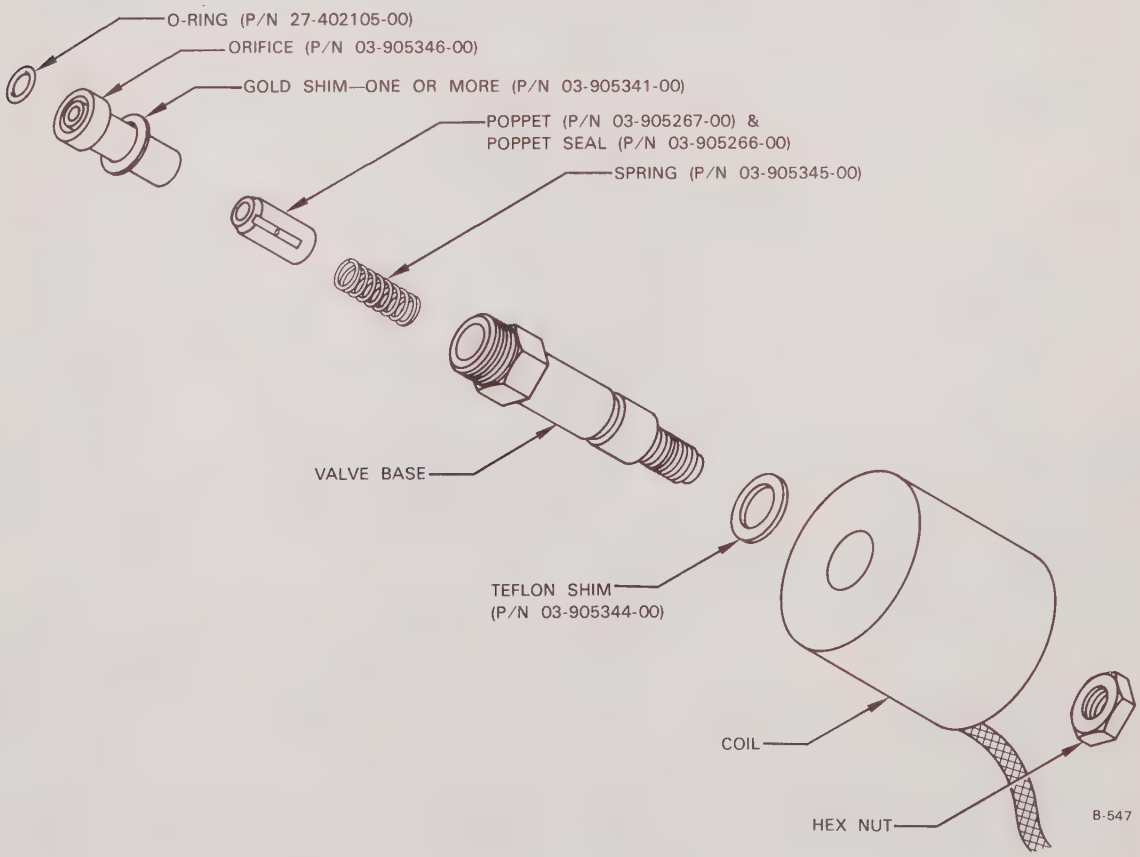


FIGURE 5-2 PROPORTIONING-VALVE ASSEMBLY

(7) Inspect the parts for wear, checking especially the spring and the poppet seal (which is embedded in face of the poppet). Worn, pitted, or cracked parts must be replaced. A repair kit (P/N 03-905650-00) containing a spring, an O-ring, a poppet seal, three gold shims, a Teflon shim, and an instruction sheet is available from Varian.

(8) Reassemble the parts of the poppet assembly, seating a new O-ring (P/N 27-402105-00) in the valve orifice and using one, two, or three new gold shims (P/N 03-905341-00), depending on the number discarded in step (5).

(9) Insert the valve base into the inlet-valve head and ***tighten it only moderately***—about 1/8-turn past finger-tight (30-34 in.-lb). Replace the Teflon shim and the coil, and tighten the hex nut at the base of the coil about 1/4-turn past finger-tight (25-30 in.-lb). Replace the solvent inlet line, following the precautions outlined in paragraph 2.3.2. After repriming the pump, run it for a short time to ensure that no leaks appear at the inlet port of the inlet-valve head. If a leak appears, tighten the valve body with a 1/2" wrench until the leak is corrected.

5.4.3 Pump

- **Replacing the Inlet-Valve Seat and O-ring, and the Inlet-Valve Seal and Bushings**

  → a leaky valve seat will cause flow rates to drop and can cause solvent backflow from the main piston chamber during the pump stroke, thus producing chromatograms with longer retention times

  → a defective seal will produce bubbles in the solvent stream and can cause nonreproducible chromatograms

(1) Turn off the main power switch on the Model 5000.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be turned off.

(2) Remove the bleed-valve assembly from the pump head. Disconnect and remove the 1/16" interconnect tube from the inlet-valve and pump heads by loosening the small nuts on the compression fittings. Two wrenches are necessary for the lower fitting, one to hold the 1/2" interconnect-tube fitting (Figure 5-3), another to loosen the compression nut. If proportioning valve C is installed, remove it (see paragraph 5.4.2).

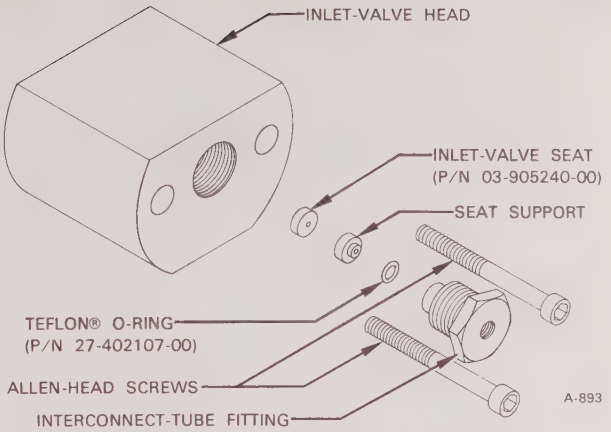


FIGURE 5-3 INLET-VALVE HEAD (FRONT)

(3) Remove the top cover from the main cabinet by unscrewing the two screws inside the main cabinet door, then sliding the cover forward and lifting it from the instrument. Turn the knoblike mechanical damper on the pump motor counterclockwise until the inlet-valve needle is fully retracted from the inlet-valve head. Take care to watch the inlet-valve needle, not the main piston (see Figure 3-4).

(4) Remove the 1/2" interconnect-tube fitting from the inlet-valve head.

(5) Make sure that the inlet-valve needle is still fully retracted, then remove the two Allen-head screws from the inlet-valve head. Gently slide the valve head forward, removing it from the head mounting plate and the inlet-valve needle.

CAUTION

Slide the inlet-valve head *directly* forward. Turning it from side to side can bend the inlet-valve needle.

The entire inlet-valve-head assembly will still be attached to the instrument by the electrical leads from the proportioning valves; however, the following steps can be carried out without removing the proportioning-valve coils.

(6) Remove the inlet-valve seat, seat support, and O-ring from the front of the inlet-valve head by inserting the seat-removal tool (P/N 03-905667-00—a 3-inch length of 1/8-inch stainless-steel rod) through the rear of the assembly and pushing gently. Discard only the seat and the O-ring.

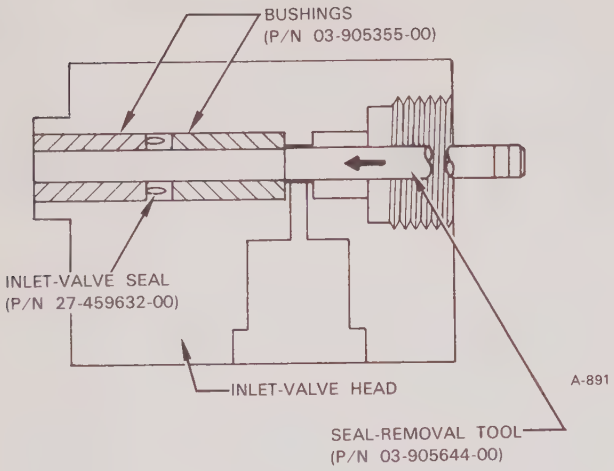


FIGURE 5-4 REMOVING THE INLET-VALVE SEAL AND BUSHINGS

(7) Insert the seal-removal tool (P/N 03-905644-00) in the front of the head, as shown in Figure 5-4, to remove the two bushings and the inlet-valve seal. ***The tool must be used as shown, with the unchamfered end—opposite the end with the two scribed lines—inserted into the head.*** It may be necessary to tap the tool lightly to force the bushings out of the valve head. Discard the seal and both bushings.

(8) As shown in Figure 5-5, slide a new bushing (P/N 03-905355-00) into the valve head. Thoroughly wet a new seal (P/N 27-459632-00) with isopropanol, then place it behind the bushing ***with the spring facing out as shown in the inset of Figure 5-5.*** Finally, insert a second bushing.

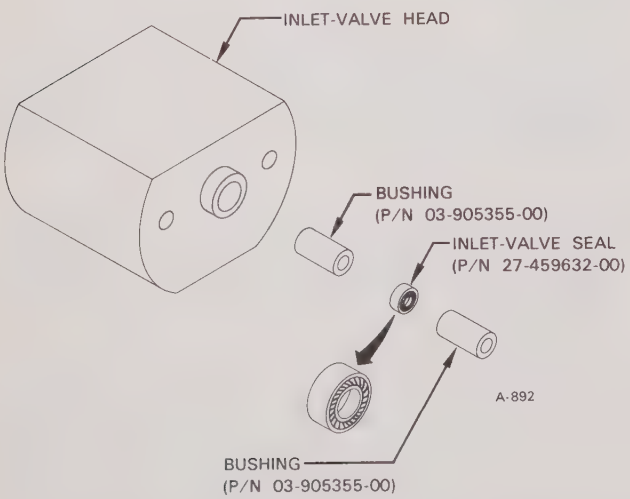


FIGURE 5-5 INLET-VALVE HEAD (REAR)

(9) Before reinstalling the inlet-valve head, clean the end of the inlet-valve needle with a soft, lint-free cloth dampened with alcohol or acetone, then allow the needle to dry. Make sure that the inlet-valve needle is fully retracted, then carefully replace the inlet-valve head on the head mounting plate. ***Slide the head directly forward over the inlet-valve needle to avoid bending the needle.*** Secure the head by tightening the two Allen-head screws snugly.

(10) Place the seat support, with a new Teflon O-ring (P/N 27-402107-00), and a new inlet-valve seat (P/N 03-905240-00) on the smaller end of the Nylon tool (P/N 03-905594-00) provided in the accessory kit. Note the orientation of each part in Figure 5-6. Press the three components firmly into the inlet-valve head.

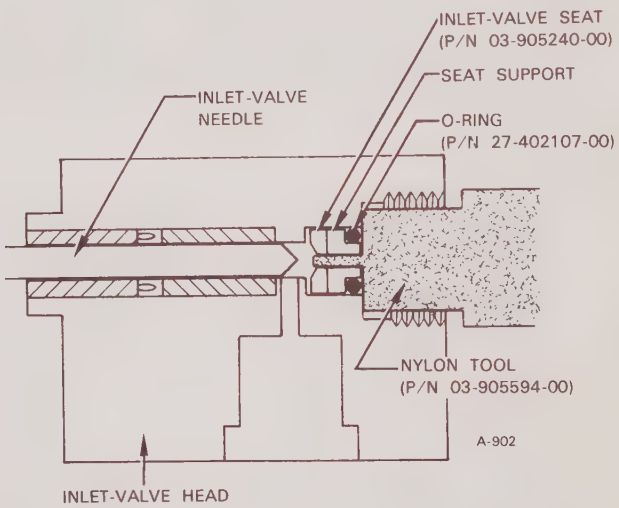


FIGURE 5-6 INSTALLING A NEW INLET-VALVE SEAT AND O-RING

(11) After removing the Nylon tool, replace the interconnect-tube fitting in the valve head, ***tightening it only enough to seat the components.*** Rotate the damper on the pump motor until the inlet-valve needle rests on the seat, then tighten the interconnect-tube fitting ***moderately***— 28-32 in.-lb (see the NOTE in paragraph 5.1).

CAUTION

Overtightening the fitting will deform the valve seat.

(12) Replace the 1/16" interconnect tube, the bleed-valve assembly, and the top cover of the main cabinet.

(13) Before resuming routine operation, it is now necessary to run the pump briefly with isopropyl alcohol to ensure that the inlet-valve seal is properly conditioned. Remove as much foreign solvent as possible from the solvent lines, then run the pump for five or ten minutes at 2.0 ml/min with the isopropyl alcohol.

- **Replacing the Piston Seal and Back-up Washer**

  → a faulty seal will allow leakage around the piston at the head mounting plate or around the base of the pump head; flow rates will be low, thus producing chromatograms with longer retention times

(1) Turn off the main power switch on the Model 5000.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be turned off.

(2) Remove the bleed-valve assembly from the pump head. Disconnect and remove the 1/16" interconnect tube from the inlet-valve and pump heads by loosening the small nuts on the compression fittings. Two wrenches are required for the lower fitting, one to hold the larger (1/2") fitting in place, another to loosen the compression nut.

(3) Remove the 1/16" tubing from the top of the check-valve assembly, using a second (5/8") wrench to hold the upper body of the assembly. Remove the check-valve assembly from the pump head by using a 5/8" wrench on the ***lower body*** of the assembly.

(4) Remove the top cover from the main cabinet by unscrewing the two screws inside the main cabinet door, then sliding the cover forward and lifting it from the instrument. Rotate the knoblike mechanical damper on top of the pump motor counterclockwise until the sapphire piston is fully retracted from the pump head. If necessary, hold the damper in this position while removing the pump head in the step below.

(5) Refer to Figure 5-7, then remove the two Phillips-head screws from the pump head. Gently slide the pump head forward, removing it from the two mounting studs and the sapphire piston.

CAUTION

Slide the pump head *directly* forward. Turning it from side to side can break the piston.

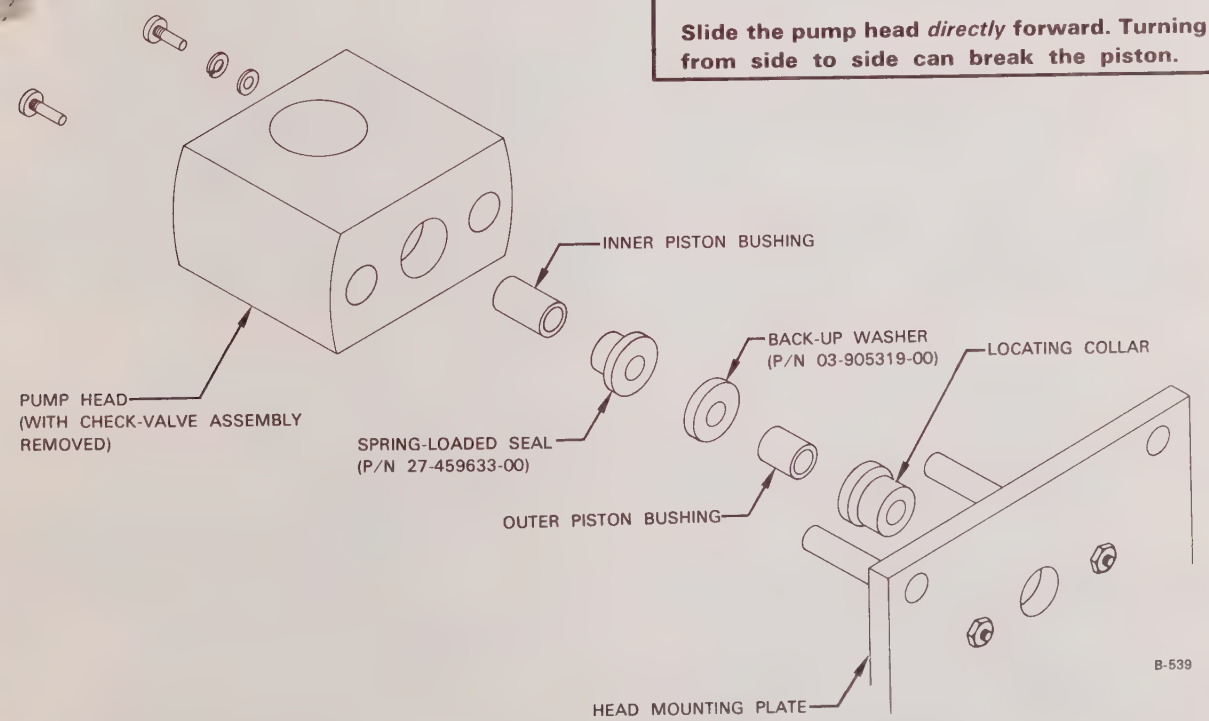


FIGURE 5-7 PUMP-HEAD ASSEMBLY

(6) When the pump head is removed from the piston and the head mounting plate, the locating collar and the outer piston bushing will usually remain on the piston and in the mounting plate. If not, remove them from the pump head and slide them onto the piston. The other components shown in Figure 5-7 will remain in the pump head. To remove the spring-loaded piston seal and the back-up washer from the pump head, use the inlet-valve seat-removal tool (P/N 03-905667-00—a 3-inch length of 1/8-inch stainless-steel rod) which has the same diameter as the sapphire piston. Insert the tool into the piston seal, then withdraw the tool, canting it to one side to remove the seal. There is no need to remove the inner piston bushing from the pump head.

(7) Wipe the cavity in the pump head, from which the seal has just been removed, with a lint-free cloth dampened with alcohol.

(8) The new spring-loaded piston seal (P/N 27-459633-00) must be inserted in the pump head using the Nylon tool (P/N 03-905594-00) provided in the accessory kit. After thoroughly wetting the new seal with isopropanol, place it on a flat, clean surface ***with the spring facing down.*** Firmly insert the larger end of the Nylon tool in the seal, then with the inner piston bushing in place in the pump head, use the tool as shown in Figure 5-8 to press the seal snugly into the pump head.

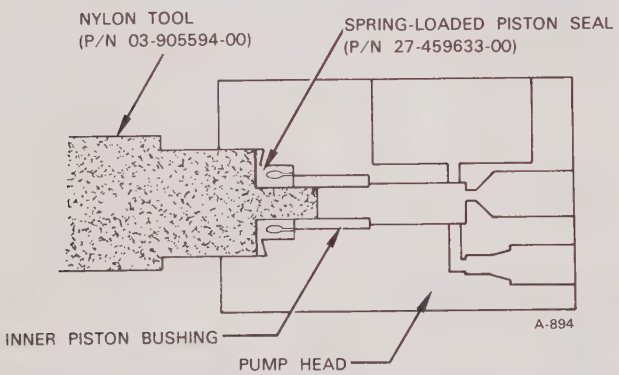


FIGURE 5-8 INSERTING A NEW PISTON SEAL

(9) Place a new washer (P/N 03-905319-00) behind the piston seal.

(10) With the sapphire piston fully retracted, carefully slide the pump-head assembly over the piston and the mounting studs and secure it to the mounting plate with the two Phillips-head screws.

(11) Follow steps (3) through (5) in paragraph 5.4.4 to replace the 2-μ filter and the O-ring in the check-valve assembly and to reinstall the assembly on the pump head.

NOTE

The check-valve filter should be replaced when the piston seal is replaced, since debris from a faulty seal may have clogged the filter.

(12) Replace the 1/16" interconnect tube, the bleed-valve assembly, and the top cover of the main cabinet.

(13) Before resuming routine operation, it is now necessary to run the pump briefly with isopropanol to ensure that the piston seal is properly conditioned. Remove as much foreign solvent as possible from the solvent lines, then run the pump for five or ten minutes at 2.0 ml/min with the isopropyl alcohol.

5.4.4 Check-Valve Assembly

→ a clogged filter may cause the pump to stall; the filter should also be replaced whenever the piston seal is replaced

(1) Turn off the main power switch on the Model 5000.

CAUTION

To prevent the pump from being inadvertently turned on during the following steps, the instrument power should be turned off.

(2) Refer to Figure 5-9 during the following steps. Remove the 1/16" tubing from the check-valve assembly, using a second (5/8") wrench to hold the

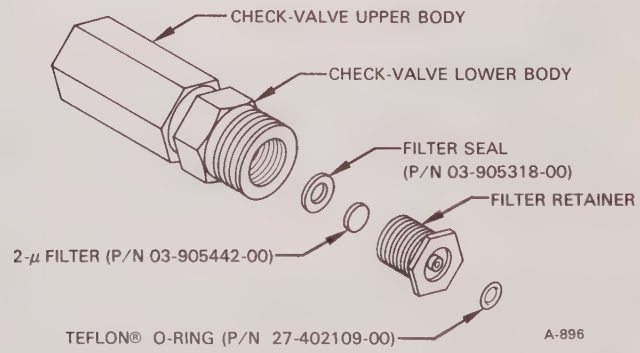


FIGURE 5-9 CHECK-VALVE ASSEMBLY

assembly body in place. Remove the check-valve assembly from the pump head by using a 5/8" wrench on the ***lower body*** of the assembly.

(3) Using a 7/16" wrench, remove the filter retainer from the check-valve assembly and discard the old filter, filter seal, and Teflon O-ring. Soak the filter retainer and the rest of the assembly in alcohol or acetone to remove particulate contamination. Allow the parts to dry thoroughly.

(4) Install a new filter seal (P/N 03-905318-00) and a 2-μ filter (P/N 03-905442-00) in the cavity of the filter retainer, then reinstall the filter retainer in the check-valve assembly. Tighten it ***moderately***—30-35 in.-lb. (see the NOTE in paragraph 5.1). Install a new O-ring (P/N 27-402109-00) in the base of the filter retainer and reinstall the assembly on the pump head. Tighten it snugly—110-120 in.-lb.

(5) Reinstall the 1/16" tubing on the top of the check-valve assembly.

5.4.5 Flow Controller

- **Replacing the Spring-Loaded Seal**

  → a leaky seal will cause erroneous flow rates and solvent leakage around the upper body of the flow controller

(1) Turn off the main power switch on the Model 5000.

CAUTION

To prevent the pump from being inadvertently turned on during the following steps, the instrument power must be turned off.

It is also important that the large knob on the upper body of the flow controller not be turned during the following steps. If the setting of this knob is changed, it will be necessary to re-establish the proper regulated backpressure as described in paragraph 5.5.3.

(2) Remove both 1/16" solvent lines from the flow-controller assembly by loosening the small compression nuts. Remove the three Phillips-head screws holding the controller mounting bracket to the rear wall of the reservoir compartment, then remove the bracket from the controller assembly by removing the two remaining Phillips-head screws.

(3) Referring to Figure 5-10, remove the four Allen-head cap screws from the lower body of the flow controller. Separate the upper and lower bodies of

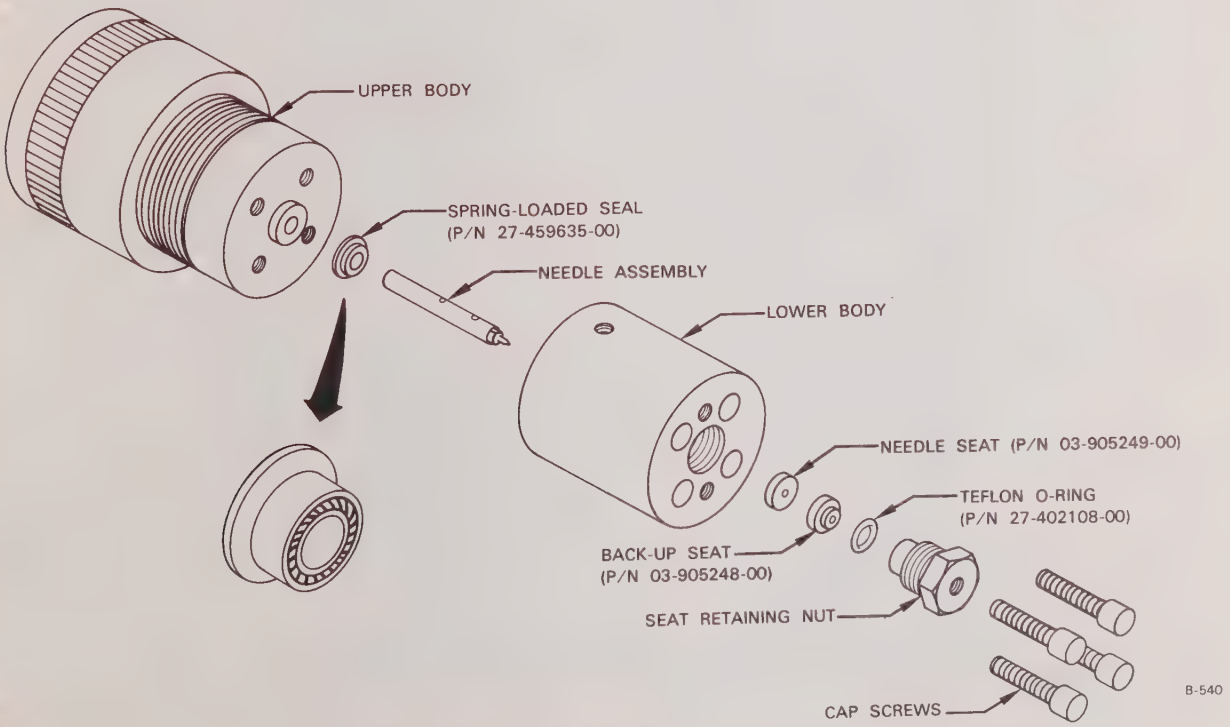


FIGURE 5-10 FLOW-CONTROLLER ASSEMBLY

the assembly, and remove the spring-loaded seal and needle assembly. Take care when handling the needle assembly; it comprises several small components that can be easily lost.

(4) Discard the old seal and soak the needle assembly in alcohol or acetone. If necessary, wipe the end of the inner needle with a clean, lint-free cloth to remove contaminants.

(5) After thoroughly wetting a new seal (P/N 27-459635-00) with isopropanol, slide it onto the needle assembly, observing the following two precautions. First, ensure that the seal has the orientation shown in Figure 5-10. Second, slide the seal over the rear, chamfered end of the needle assembly, and do not allow the seal to slide over the holes in the side of the needle assembly.

CAUTION

The seating surface of the seal can be ruined if it is allowed to slide over the holes in the needle assembly or over the unchamfered end through which the inner needle protrudes.

(6) Reinstall the needle assembly in the lower body of the flow controller. Reassemble the controller, tightening the cap screws snugly.

(7) Mount the mounting bracket on the controller assembly and install the bracket in the reservoir compartment. Reinstall the 1/16" tubing on the controller.

- **Replacing the Needle Seat and O-ring**

  → a leaky seat will cause the regulated backpressure to drop and the flow rate to increase, thus decreasing retention times

When replacing the needle seat and O-ring, it is also necessary to replace the spring-loaded seal; therefore, the steps immediately above will be an integral part of the following procedure.

(1) Follow steps (1) through (4) under **Replacing the Spring-Loaded Seal** above, carefully observing the CAUTION.

(2) Remove the 1/2" seat retaining nut from the base of the lower body. Insert the seat-removal tool (P/N 03-905667-00—a 3-inch length of 1/8-inch stainless-steel rod) in the upper end of the lower body and push the needle seat, back-up seat, and O-ring out the lower end of the assembly. Discard the needle seat and O-ring.

(3) Place a new needle seat (P/N 03-905249-00) in the lower body, making sure that the beveled seating surface is facing the upper end of the body. Place a new O-ring (P/N 27-402108-00) on the back-up seat, then replace the back-up seat in the lower body, observing the orientation shown in Figure 5-10. Replace the seat retaining nut, ***tightening it only enough to seat the components.***

(4) Follow steps (5) and (6) under **Replacing the Spring-Loaded Seal** above, then tighten the seat retaining nut ***securely***—about 80 in.-lb. Reinstall the flow controller.

CAUTION

The seat retaining nut must be tightened securely to ensure the proper regulated backpressure. As a precaution the backpressure can be checked as described in paragraph 5.5.3.

5.4.6 Loop Injector

→ loose Belleville spring washers will cause cross-port leaks and nonreproducible chromatograms.

The sealing force for the rotary valve of the loop injector is provided by a stack of 16 Belleville spring washers on the valve shaft behind the ported valve body. Cross-port leaks can often be corrected by increasing the pressure on these Belleville washers as follows.

Loosen the Allen-head cap screw in the locking collar that holds the Belleville washers in place. Using a pair of pliers, tighten the locking collar clockwise 1/6-turn, then retighten the cap screw. If this does not correct the leak, the procedure can be repeated. If after the locking collar is repeatedly tightened the valve handle becomes difficult to turn, the entire valve should be replaced.

5.5 NONROUTINE SERVICE

5.5.1 Proportioning Valve

→ a faulty proportioning valve coil will produce bubbles in the solvent stream and can cause the pump to lose prime; proportioning will be inaccurate, thus producing nonreproducible chromatograms

Paragraph 5.4.2 (under **Cleaning the Poppet Assembly)** describes the procedure for cleaning or replacing the components of the poppet assembly. If the coil fails, however, additional steps are necessary to con-

nect the electrical leads to the power-control printed-circuit board of the instrument.

(1) Turn off the main power switch on the Model 5000.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be turned off.

(2) Remove the solvent inlet line from the proportioning valve by loosening the compression fitting at the base of the assembly. (To service valve C, it will be necessary to remove the drip tray.)

(3) Remove the old coil and Teflon shim (Figure 5-2) by removing the 1/2" hex nut at the base of the coil.

(4) Remove the top cover of the instrument by removing the two screws inside the main cabinet door, then sliding the top cover forward and lifting it from the instrument. Remove the eight Phillips-head screws that secure the pump shroud to the floor and rear wall of the reservoir compartment. Remove the pump shroud by lifting it out the top of the instrument.

(5) Notice how the electrical leads of the proportioning valve are routed from the coil to the power-control PC board (see Figure 5-11). Unplug the leads for the coil being replaced and remove the coil from the front of the reservoir compartment.

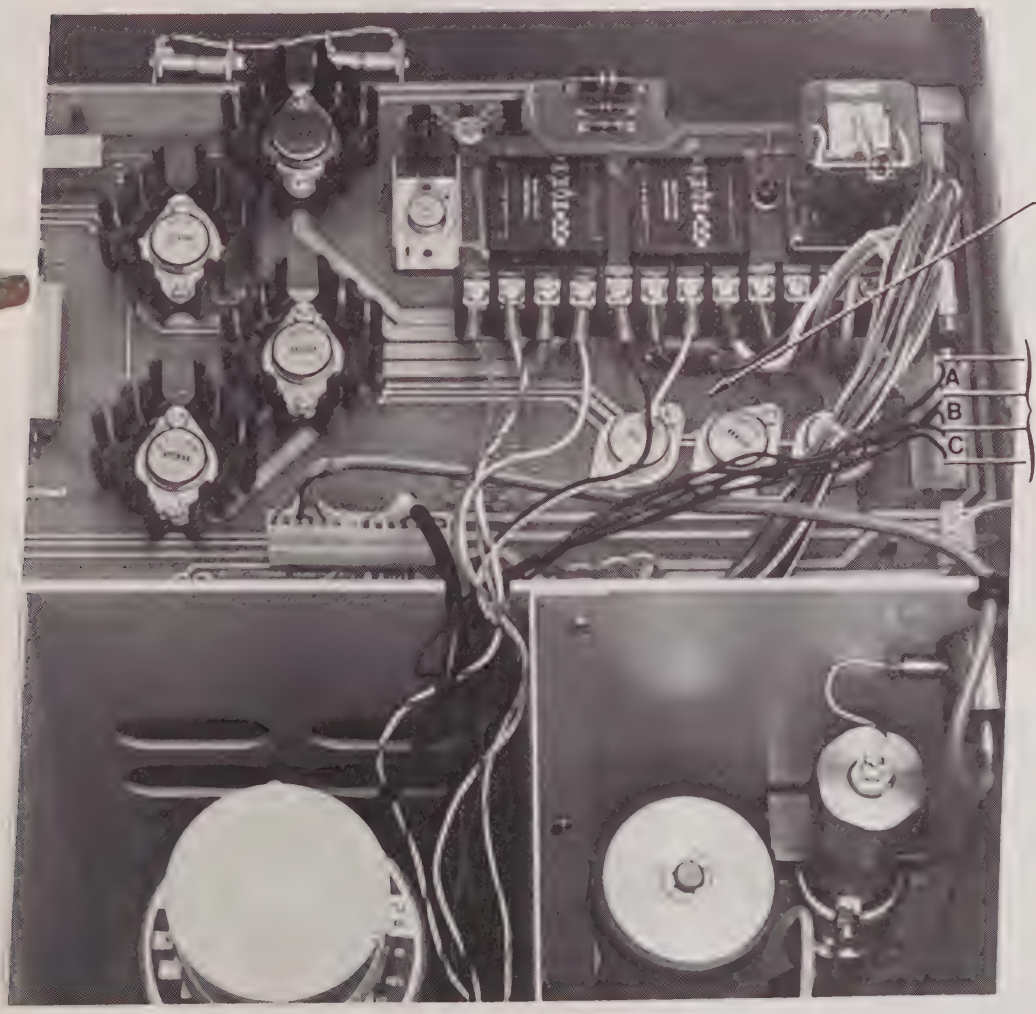


FIGURE 5-11 PROPORTIONING-VALVE CONNECTIONS TO POWER-CONTROL PC BOARD

(6) Route the wires from the new coil (P/N 03-905374-00) through the pump compartment and plug the connector into the appropriate receptacle on the power-control PC board.

(7) Reinstall the new coil and the Teflon shim on the poppet assembly, tightening the hex nut at the base of the coil only about 1/4-turn past finger-tight (25-30 in.-lb). Replace the solvent inlet line, following the precautions noted in paragraph 2.3.2.

(8) Reinstall the pump shroud (eight screws) and the top cover of the main cabinet.

5.5.2 Pump

- **Replacing the Bleed-Valve Needle Tip**
  - → a faulty tip will cause leakage from the bleed-valve port

(1) Turn off the main power switch on the Model 5000.

CAUTION

To prevent the pump from being inadvertently turned on during the following steps, the instrument should be turned off.

(2) Remove the bleed-valve needle completely from the pump head. With a pair of pliers pull the needle tip from the needle. Replace it with a new needle tip (P/N 03-905289-00).

(3) Reinstall the bleed-valve needle in the pump head.

- **Replacing the Piston**
  - → the piston should need replacement only if it is scratched or broken through mishandling

(1) Turn off the main power switch on the Model 5000.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be turned off.

(2) Remove the bleed-valve assembly from the pump head. Remove the 1/16" interconnect tube from the inlet-valve and pump heads by loosening the nuts on the two compression fittings. Two wrenches are necessary to loosen the lower fitting, one to hold the larger (1/2") fitting in place. Remove the 1/16" tubing from the top of the check-valve assembly, using one 5/8" wrench to hold the upper body of the assembly while loosening the compression fitting.

(3) Remove the top cover of the main cabinet by removing the two screws inside the main cabinet door, then sliding the top cover forward and lifting it from the instrument. Turn the knoblike mechanical damper on the pump motor counterclockwise until the pump piston is fully extended, exposing as much of the piston slider as possible (see Figures 3-4 and 5-12).

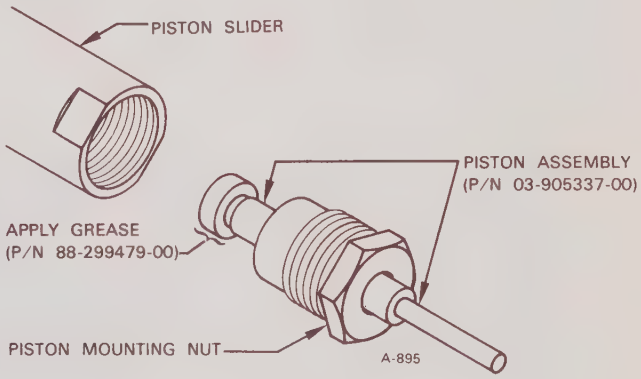


FIGURE 5-12 PISTON ASSEMBLY

(4) Using an 11/16" wrench to hold the piston slider securely, loosen the piston mounting nut with a second (5/8") wrench. ***When loosening the mounting nut avoid exerting any torque on the piston slider.***

(5) Rotate the damper on the pump motor 1/2-turn counterclockwise, then remove the two Phillips-head screws from the front of the pump head. Gently slide the pump head forward, removing it from the two mounting studs and the piston.

CAUTION

Slide the pump head *directly* forward. Turning it from side to side can break the sapphire piston.

(6) The locating collar and outer piston bushing (see Figure 5-7) will probably remain in the mounting plate. To remove them, work them out gently with your fingers while rotating the damper on the pump motor counterclockwise. Slide them off the piston.

(7) Return the piston to its fully extended position, continue loosening the piston mounting nut, and re-

move the piston and the mounting nut from the pump assembly.

Apply grease (P/N 88-299479-00) liberally to the base of the new piston assembly (P/N 03-905337-00), slide the mounting nut over the piston, then reinstall the assembly in the piston slider, leaving it slightly loose.

(9) Replace the locating collar and outer piston bushing in the head mounting plate, working them into place gently while turning the damper on the pump motor counterclockwise. With the piston fully retracted remount the pump head on the head mounting plate, taking care to slide it gently over the piston. Replace the two Phillips-head screws in the pump head.

(10) Return the piston to its fully extended position. Again using two wrenches, tighten the piston mounting nut moderately ***while holding the piston slider securely***.

(11) Reinstall the 1/16" tubing to the check-valve assembly, reinstall the interconnect tube, and replace the bleed-valve assembly. Replace the top cover on the main cabinet.

5.5.3 Flow Controller—Adjusting the Backpressure

→ a misadjusted flow controller will cause the efficiency of the pump to be higher or lower than normal, thus altering retention times

If the large knob on the flow controller is inadvertently turned, or if it is necessary to change the regulated backpressure to a value above or below the factory-set 3500 psi, the pressure transducer in the Model 5000 can be used for the readjustment.

(1) Turn off the main power switch on the Model 5000.

WARNING

SHOCK HAZARD

Dangerous voltages are exposed in the following steps. The instrument *must* be turned off whenever the top cover is removed.

(2) Remove the top cover of the main cabinet by removing the two screws inside the main cabinet door, then sliding the top cover forward and lifting it from the instrument. Remove the side panel from the column enclosure.

(3) Disconnect both pieces of 1/16" tubing from the pressure transducer, and disconnect the 1/16" tubing from the ***side*** of the flow controller.

(4) Remove the pressure transducer from the rear wall of the reservoir compartment by loosening the single screw holding it in place. Replumb the hydraulics system so that the transducer is between the check-valve assembly and the inlet of the flow controller. The transducer can be connected directly to the tubing (from the check-valve assembly) that has been removed from the flow controller, and a second piece of tubing connected between the transducer and the flow controller. The standard accessory kit contains a one-foot length of 1/16" tubing (P/N 37-000654-00).

(5) Connect a piece of Teflon tubing to the exit of the pulse damper, and run it to a waste container. With the pressure transducer still connected electrically to the power-control printed-circuit board, replace the top cover of the main cabinet.

(6) Turn the instrument on. Set PMAX to 300 atm and the flow rate to 1.0 ml/min, then start the pump. Allow the flow to equilibrate, then adjust the large knob on the flow controller until the pressure reading on the CRT corresponds to the desired backpressure (3500 psi = 238 atm). Ensure that the pressure does not change for several minutes, then turn off the instrument.

(7) Again remove the top cover of the main cabinet, remount the pressure transducer on the rear wall of the reservoir compartment, replumb it properly, and reconnect the tubing from the check-valve assembly to the inlet of the flow controller. Replace the top cover of the instrument and the side panel of the column enclosure.

5.5.4 Stop-Flow Injector

→ a faulty seal will cause leakage, probably out the purge vent; a faulty O-ring can cause leakage around the plug at the top of the injector body

(1) Ensure that the pump is stopped and that the column is at atmospheric pressure, then remove the injector plug from the injector body.

(2) With a pair of pliers pull the injector seal from the seal retainer (see Figure 3-7). Unscrew the seal retainer from the body of the plug, then remove the Teflon O-ring.

(3) Replace the O-ring (P/N 27-402105-00), reinstall the seal retainer, and insert a new seal (P/N 03-905347-00) in the retainer. Reinstall the injector plug.

SECTION 6
DRAWINGS AND PARTS LISTS

This section includes schematic and assembly drawings for the Model 5000 LC. For replacement parts or service, contact the nearest Varian Sales Office or Service Center. Include the serial numbers of your instrument.

Listed below are the drawings included in this section.

Drawing Title	Page
Model 5000 Kit Parts Lists	6-3
Pump & Valve Logic PC Board Assembly Drawing 03-905403-00	6-4
Pump & Valve Logic PC Board Schematic Diagram 03-905400-00	6-5
Converter PC Board Assembly Drawing 03-905429-00	6-6
Converter PC Board Schematic Diagram 03-905426-00	6-7
CPU PC Board Assembly Drawing 03-905353-00	6-8
CPU PC Board Schematic Diagram 03-905350-00	6-9
CRT & Interrupt Controller PC Board Assembly Drawing 03-905416-00	6-10
CRT & Interrupt Controller PC Board Schematic Diagram 03-905413-00	6-11
RAM/ROM/PROM PC Board Assembly Drawing 03-905391-00	6-12
RAM/ROM/PROM PC Board Schematic Diagram 03-905388-00	6-13
Regulator PC Board Assembly Drawing 03-905433-00	6-14
Regulator PC Board Schematic Diagram 03-905430-00	6-15
Temperature Controller PC Board Assembly Drawing 03-905412-00	6-16
Temperature Controller PC Board Schematic Diagram 03-905409-00	6-17
Option PC Board Assembly Drawing 03-905536-00	6-18
Option PC Board Schematic Diagram 03-905539-00	6-19
RAM Power Supply & Battery Back-Up Assembly Drawing 03-905532-00	6-20
RAM Power Supply & Battery Back-Up Schematic Diagram 03-905535-00	6-21
Power Control PC Board Assembly Drawing 03-905408-00	6-22
Power Control PC Board Schematic Diagram 03-905405-00	6-23
CRT/Charger Module Assembly Drawing 03-905404-00	6-24
Modified CRT Assembly Drawing 03-905614-01	6-25
CRT Interconnect Cable Assembly Drawing 03-905464-00	6-26
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Proportioning Valve Assembly Drawing 03-905263-00	6-30
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Stop Flow Injector Assembly Drawing 03-905208-00	6-34
30-cm Column Heater Block Assembly Drawing 03-905602-00	6-35
50-cm Column Heater Block Assembly Drawing 03-905398-00	6-36

PRESSURE REGULATOR REPAIR KIT 03-905645-00 Rev A

Qty	Part Number	Description
1 ea.	27-459634-00	Seal, TFE, Regulator
1 ea.	27-402108-00	O-Ring
1 ea.	03-905249-00	Seat, Regulator

INLET VALVE REPAIR KIT 03-905662-00 Rev A

Qty	Part Number	Description
1 ea.	03-905240-00	Seat, Inlet Valve
1 ea.	27-459632-00	Seal, TFE, Dynamic .125 ID x .245 OD
1 ea.	27-402107-00	O-Ring, TFE, .114 ID x .070 Wide
2 ea.	03-905355-00	Bushing, Inlet Valve

MODEL 5000 TOOL KIT 03-905648-00 Rev A

Qty	Part Number	Description
1 ea.	03-905594-00	Tool, Pump Piston Seal Installation
1 ea.	72-000016-00	Wrench, Allen, 5/32
1 ea.	29-899420-00	Mirror, Inspection, Plastic
1 ea.	03-905644-00	Tool, Inlet Seal Removal
1 ea.	03-905666-00	Tool, Encoder Disc Adjustment
1 ea.	03-905667-00	Tool, Piston Seal & Inlet Seat Removal

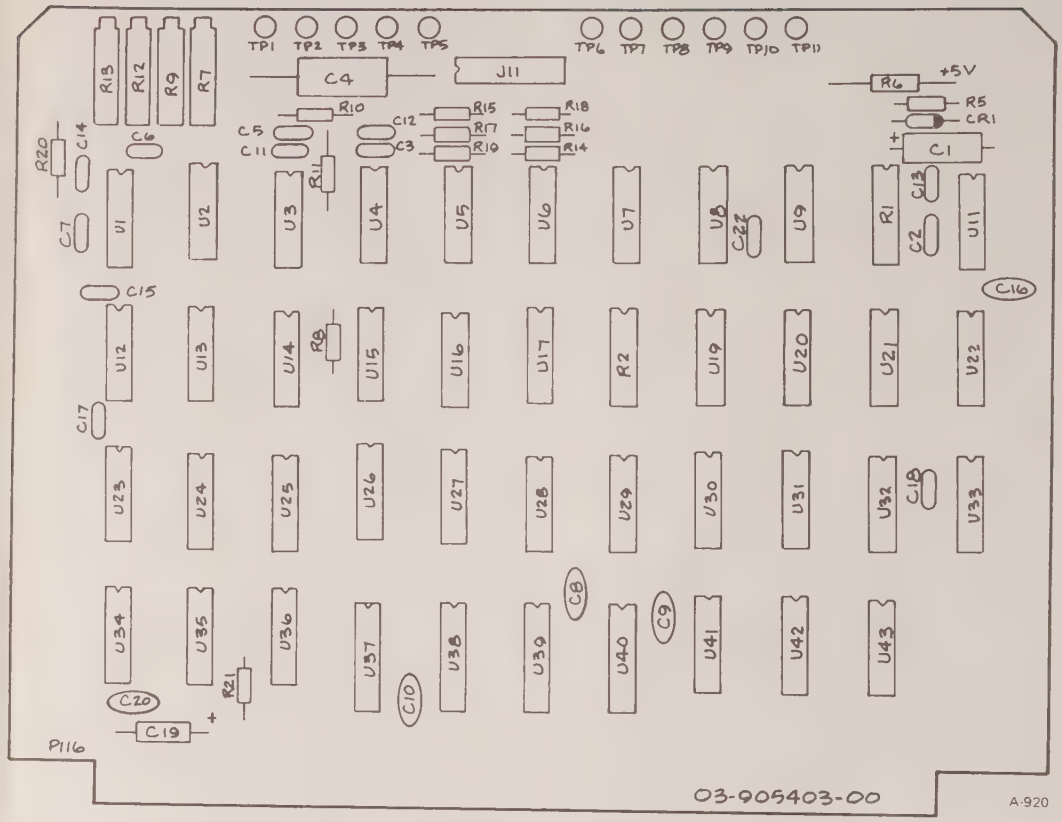
PISTON SEAL REPAIR KIT 03-905643-00 Rev B

Qty	Part Number	Description
2 ea.	27-402109-00	O-Ring, Check Valve
2 ea.	03-905318-00	Seal, Filter, Check Valve
2 ea.	03-905442-00	Frit, 2 μ, Check Valve
2 ea.	27-459633-00	Seal, Pump Piston
2 ea.	03-905319-00	Washer

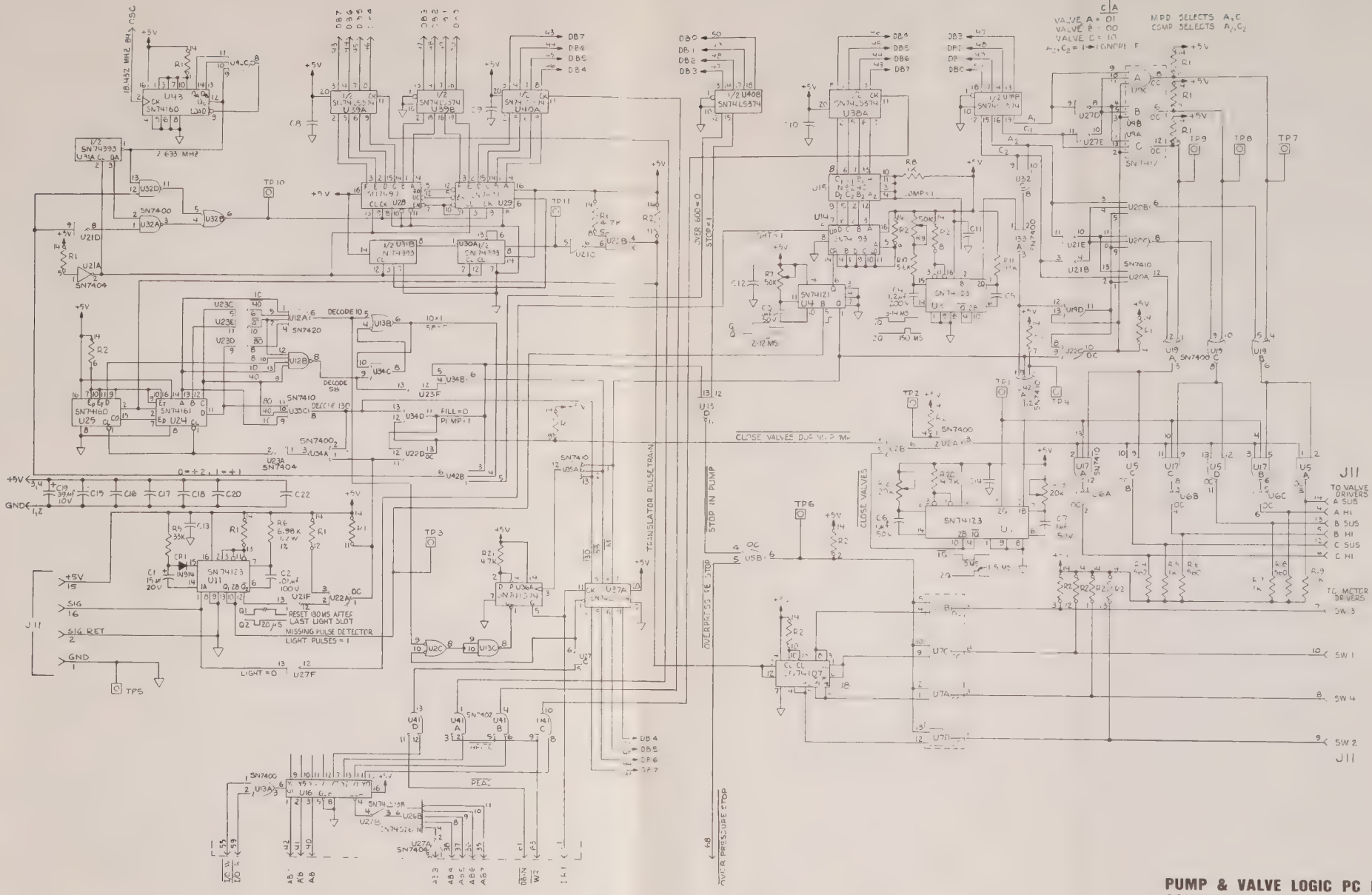
VARIABLE TERMINATOR KIT 03-905646-00 Rev B

Qty	Part Number	Description
1 ea.	27-189070-00	Terminator, Variable
1 ea.	22-129965-00	Clip, Spring
1 ea.	02-000315-00	Adapter, 1/4 to 1/8
1 ea.	03-905498-00	Adapter, 1/16 to 1/4
1 ea.	16-000441-00	Ferrule, 1/8, TFE
1 ea.	15-000672-01	Nut, Zero Dead Vol, 1/16 SS
2 ea.	12-222006-04	Screw, 6-32 x 1/4 Ph Hd SS
1 ea.	28-693996-00	Ferrule, Front 1/16 SS
1 ea.	28-693997-00	Ferrule, Back 1/16 SS

Schematic Reference/ Item No.	Part Number	Description
C1	41-606895-00	Capacitor, Tant 15 µF 20V
C2	05-000029-00	Capacitor, Ceramic .01 µF 100V
C3	05-000028-00	Capacitor, Ceramic 1 µF 50V
C4	05-000344-00	Capacitor, Mylar 1.2 µF 200V
C5	05-000027-00	Capacitor, Ceramic .1 µF 50V
C6, C7		Same as C3
C8-C18		Same as C5
C19	05-000494-00	Capacitor, Elect. 39 µF 10V
C20, C22		Same as C5
CR1	14-000042-00	Diode, 1N914
J11	54-604023-00	Socket, 16 pin dual in line
R1	39-000971-00	Resistor, Network, 4.7K 13R
R2		Same as R1
R5	39-000383-00	Resistor, CC 33K 1/4W 5%
R6	39-000062-00	Resistor, MF 6.98K 1/2W 1%
R7	39-000609-00	Potentiometer, 50K 15 Turn
R8	39-000419-00	Resistor, CC 1K 1/4W 5%
R9		Same as R7
R10	32-301456-00	Resistor, CC 5.6K 1/4W 5%
R11	39-000369-00	Resistor, CC 10K 1/4W 5%
R12	39-000612-00	Potentiometer, 20K 15 Turn
R13		Same as R12
R14	39-000124-00	Resistor, CC 560Ω 1/4W 5%
R15		Same as R8
R16		Same as R14
R17		Same as R8
R18		Same as R14
R19		Same as R8
R20	39-000377-00	Resistor, CC 4.7K 1/4W 5%
R21		Same as R20
U1	62-000297-00	IC, SN74123N
U2	14-000548-00	IC, SN7400N
U3		Same as U1
U4	14-000643-00	IC, SN74121N
U5	14-000598-00	IC, SN7409N
U6	62-600470-00	IC, SN7406N
U7		Same as U5
U8	14-000592-00	IC, SN74107N
U9	62-600901-00	IC, SN7412N
U11		Same as U1
U12	14-000556-00	IC, SN7420N
U13		Same as U2
U14	14-000648-00	IC, SN74193N
U15	14-000589-00	IC, N8242A
U16	62-600063-00	IC, SN74LS138N
U17	14-000562-00	IC, SN7410N
U19		Same as U2
U20		Same as U17
U21	14-000634-00	IC, SN7404N
U22	14-000552-00	IC, SN7401N
U23		Same as U21
U24	62-600533-00	IC, SN74161N
U25	62-600384-00	IC, SN74160N
U26	62-600792-00	IC, SN74S260N
U27		Same as U21
U28	62-600902-00	IC, SN7497N
U29		Same as U28
U30	62-600595-00	IC, SN74393N
U31		Same as U30
U32-U34		Same as U2
U35		Same as U17
U36	62-600714-00	IC, SN74LS74N
U37	62-600900-00	IC, SN74LS374N
U38-U40		Same as U37
U41	14-000571-00	IC, SN7402N
U42		Same as U17
U43		Same as U25
	03-905402-00	Pump & Valve Logic PCB
	25-000161-00	Handle, Card Ejector

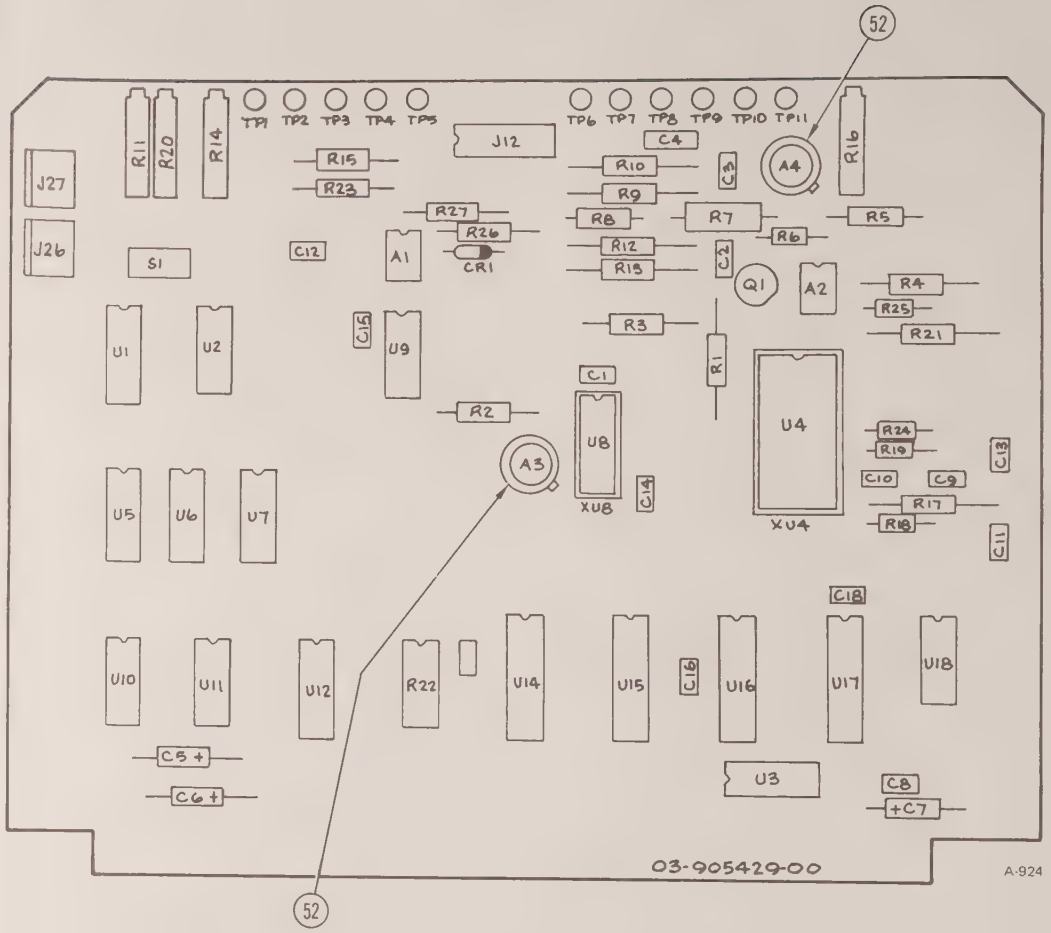


PUMP & VALVE LOGIC PC BOARD ASSEMBLY DRAWING 03-905403-00



PUMP & VALVE LOGIC PC BOARD
SCHEMATIC DIAGRAM 03-905400-00

Schematic Reference/ Item No.	Part Number	Description
A1	62-600223-00	Amplifier, LM1458N
A2		Same as A1
A3	62-600215-00	Amplifier, μA741CL
A4		Same as A3
C1	05-000025-00	Capacitor, Mica 100 pF 3 kV
C2	05-000027-00	Capacitor, Ceramic 0.1 μF 50V
C3	05-000001-00	Capacitor, 0.001 μF 1 kV
C4	05-000251-00	Capacitor, 0.047 μF 250V
C5	05-000428-00	Capacitor, Tant 10 μF 25V
C6		Same as C5
C7	05-000494-00	Capacitor, Tant 39 μF 10V
C8		Same as C2
C9	41-159601-00	Capacitor, 270 pF 500V
C10	41-159509-00	Capacitor, 68 pF 500V 1%
C11	05-000028-00	Capacitor, Ceramic 1.0 μF 50V
C12, C13		Same as C11
C14-C18		Same as C2
CR1	14-000043-00	Diode, Zener 1N752A
J12	54-634023-00	Socket, IC 16 pin Dip
J26	51-407023-00	Connector, Molex 3 pin male
J27		Same as J26
Q1	14-000509-00	Transistor, 2N3638
R1	39-000909-00	Resistor, MF 2.49K 1/2W 1%
R2	31-224619-00	Resistor, MF 6.19K 1/4W 1%
R3	31-616021-00	Resistor, MF 10K 1/2W 0.1%
R4		Same as R3
R5	31-613206-00	Resistor, MF 20K 1/4W 0.1%
R6	39-000377-00	Resistor, CC 4.7K 1/4W 5%
R7	33-301333-00	Resistor, CC 330Ω 1W 5%
R8	32-201718-00	Resistor, CC 1.8 Meg. 1/2W
R9	31-614680-00	Resistor, MF 14.3K 1/2W 1%
R10	39-000117-00	Resistor, MF 1 Meg. 1/2W 1%
R11	39-000621-00	Potentiometer, 1K 15 Turn
R12		Same as R9
R13		Same as R10
R14	39-000609-00	Potentiometer, 50K 15 Turn
R15	31-225316-00	Resistor, MF 31.6K 1/4W 1%
R16	39-000605-00	Potentiometer, 10K 15 Turn
R17		Same as R10
R18	39-000069-00	Resistor, CC 100Ω 1/4W 5%
R19	39-000978-00	Resistor, CC 100K 1/4W 5%
R20		Same as R16
R21	39-001001-00	Resistor, MF 249K 1/4W 1%
R22	39-000971-00	Resistor Network, 4.7K 13 Res.
R23	39-000992-00	Resistor, MF 10K 1/4W 1%
R24, R25		Same as R18
R26	39-000994-00	Resistor, MF 20K 1/4W 1%
R27		Same as R23
S1	71-349901-00	Switch, Slide DPDT
U1	62-600533-00	IC, SN74161N
U2	62-600595-00	IC, SN74393N
U3		Same as U2
U4	62-600924-00	IC, ADC-EK88
U5	62-600357-00	IC, SN7410N
U6	14-000571-00	IC, SN7402N
U7		Same as U6
U8	62-600049-00	IC, MC1408L
U9	62-600291-00	IC, SN74132N
U10	14-000549-00	IC, SN7473N
U11	62-600792-00	IC, SN74S260N
U12	62-600063-00	IC, SN74LS138N
U14	62-600900-00	IC, SN74LS374N
U15		Same as U14
U16	62-600874-00	IC, SN74LS241N
U17		Same as U14
U18	14-000590-00	IC, SN7406N
XU4	54-634012-00	Socket, IC, 24 pin Dip
XU8	44-000045-00	Socket, IC, 16 pin Dip
	03-905428-00	Converter PCB
52	62-899811-00	Pad, Semicond. Mtg.
	25-000161-00	Handle, Card Ejector, with pins

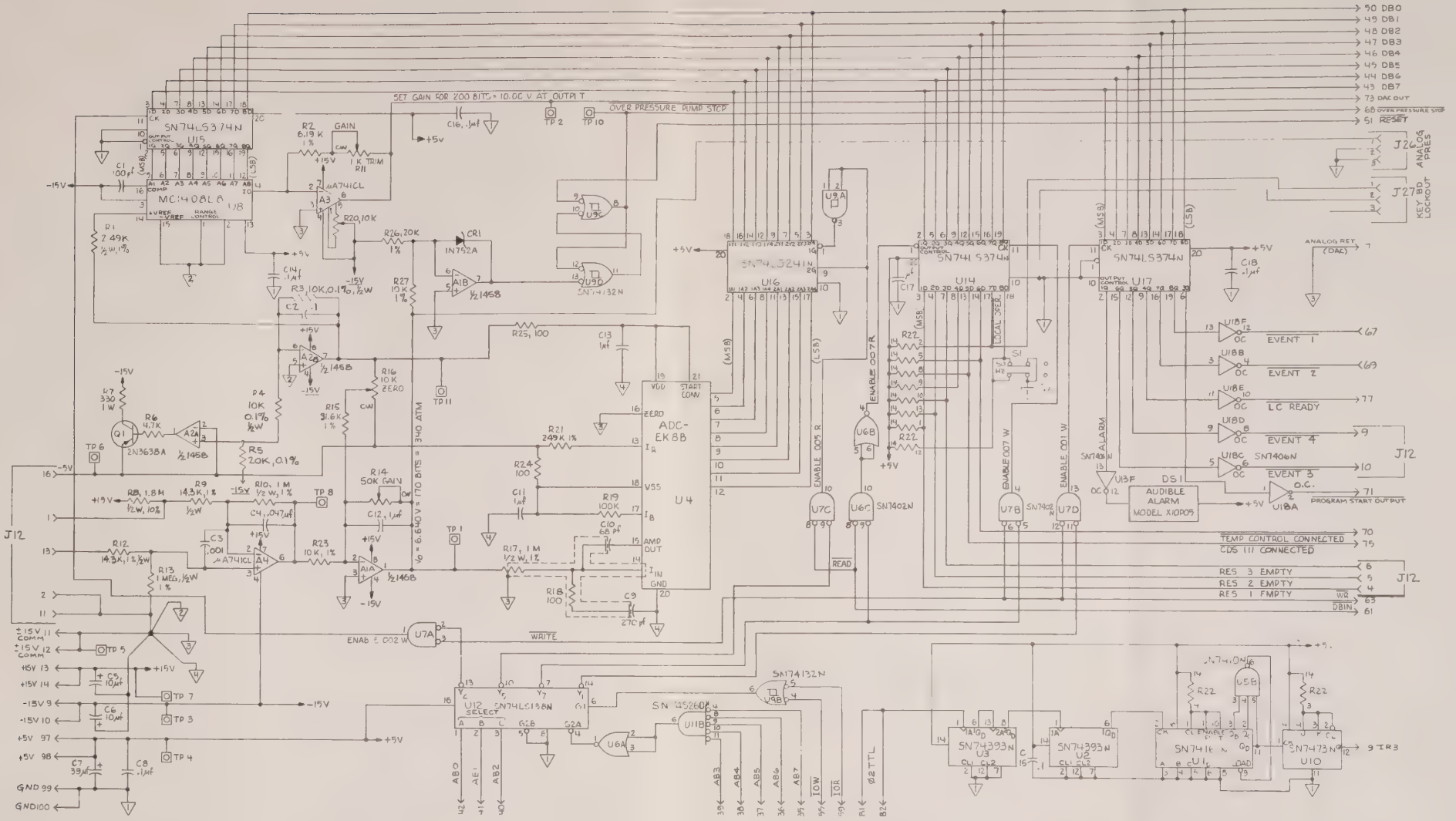


CONVERTER PC BOARD ASSEMBLY DRAWING 03-905429-00

PRESSURE TRANSDUCER CALIBRATION

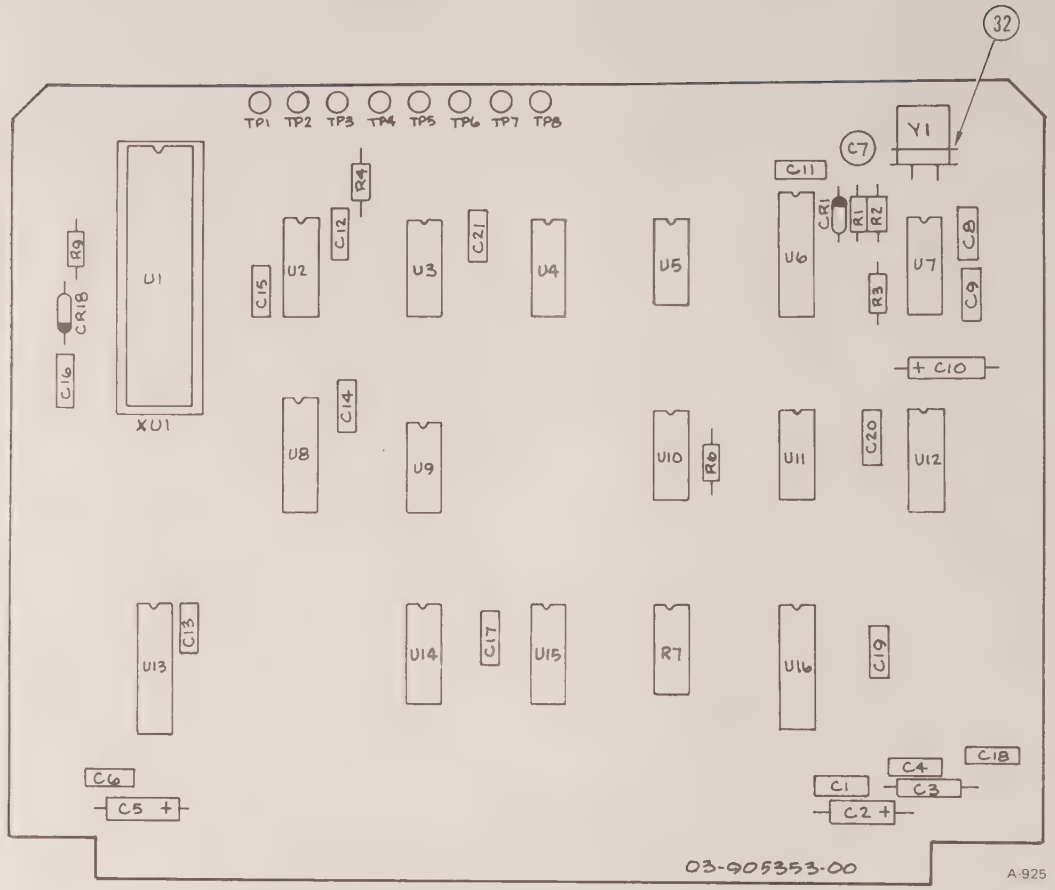
1. Shut off pump
2. Open purge valve to release pressure
3. Adjust R16 on Converter PCB for 0 ATM on the CRT.
4. Short E1 to E2 on Power Controller PCB.
5. Adjust R14 for 272 ATM on the CRT.
6. Remove short between E1 and E2

ATM	Volts
0	0,02
272	5,08
340	6.64
1 ML/min	60

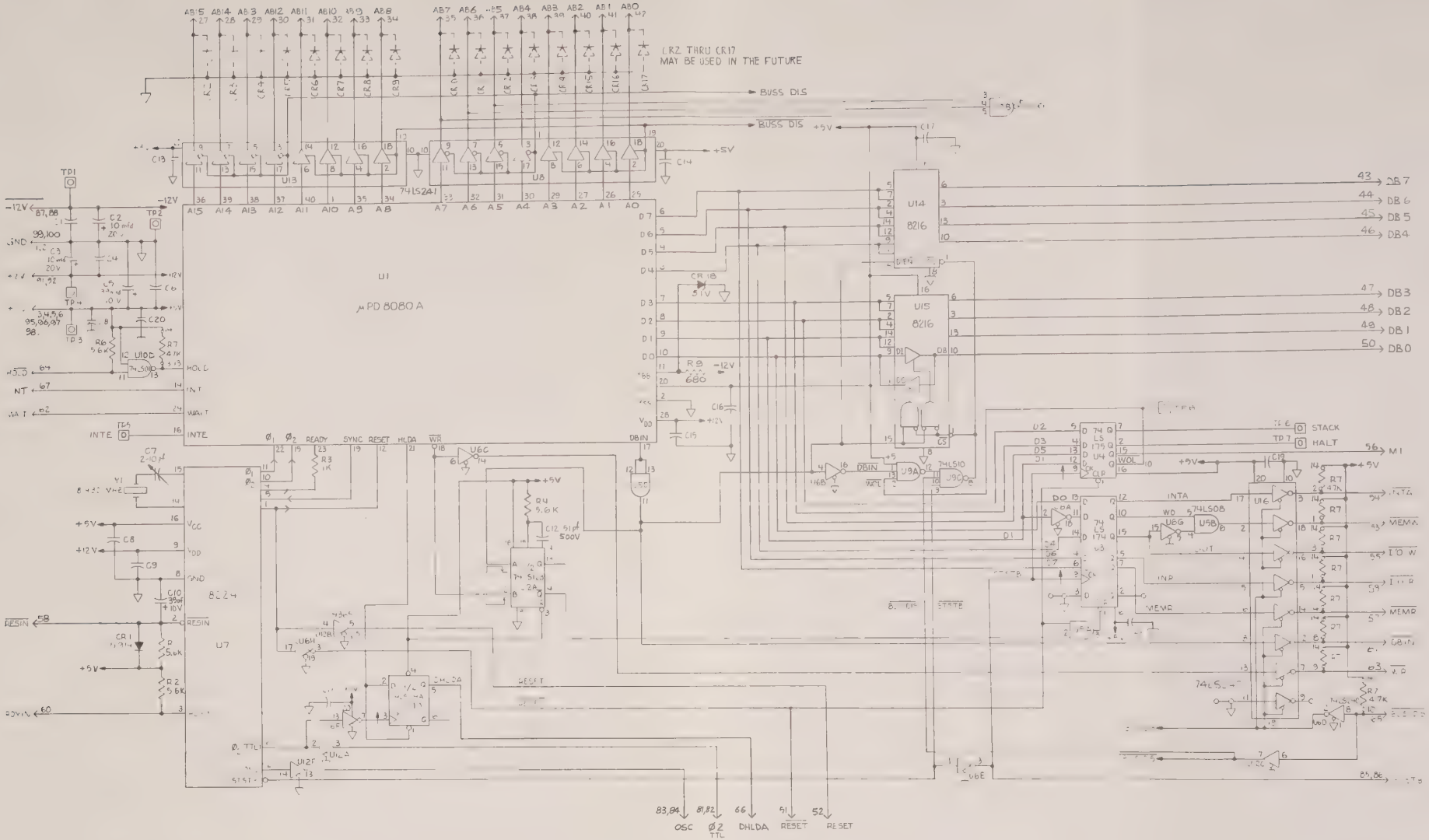


CONVERTER PC BOARD
SCHEMATIC DIAGRAM 03-905426-00

Schematic Reference/ Item No.	Part Number	Description
C1	41-206997-00	Capacitor, Ceramic 0.1 μF, 50V 20%
C2	41-609886-00	Capacitor, Tant 10 μF, 20V 20%
C3		Same as C2
C4		Same as C1
C5	41-606935-00	Capacitor, Tant 39 μF, 10V 10%
C6		Same as C1
C7	42-207066-00	Capacitor, Ceramic Var, 3-10 pF, 100V
C8, C9		Same as C1
C10		Same as C5
C11		Same as C1
C12	41-159584-00	Capacitor, Mica 51 pF, 500V 5%
C13-C21		Same as C1
CR1	66-304148-00	Diode, 1N914
CR18	66-310751-00	Diode, 1N751A, 5.1V
R1	32-301456-00	Resistor, CC 5.6K 1/4W 5%
R2		Same as R1
R3	32-301410-00	Resistor, CC 1K 1/4W 5%
R4		Same as R1
R6		Same as R1
R7	31-400038-00	Resistor Network, 4.7K .15W 2% 13 Res.
R9	32-301368-00	Resistor, CC 680Ω 1/4W 5%
U1	03-905360-00	IC, CPU PD8080AD
U2	62-600725-00	IC, SN74LS123N
U3	62-600851-00	IC, SN74LS174N
U4	62-600723-00	IC, SN74LS175N
U5	62-600717-00	IC, SN74LS08N
U6	62-600875-00	IC, SN74LS240N
U7	62-600797-00	IC, μPB8224C
U8	62-600874-00	IC, SN74LS241N
U9	62-600724-00	IC, SN74LS10N
U10	62-600737-00	IC, SN74LS01N
U11	62-600714-00	IC, SN74LS74AN
U12	62-600069-00	IC, SN74365N
U13		Same as U8
U14	62-600760-00	IC, P8216
U15		Same as U14
U16		Same as U6
XU1	54-634058-00	Socket, IC, 40 pins
Y1	66-472003-00	Crystal, Quartz, 18.432 MHz
	03-905352-00	CPU PC Board
	25-000161-00	Handle, Card Ejector
32	81-099922-00	Copper Wire, 22 GA Bare Tinned

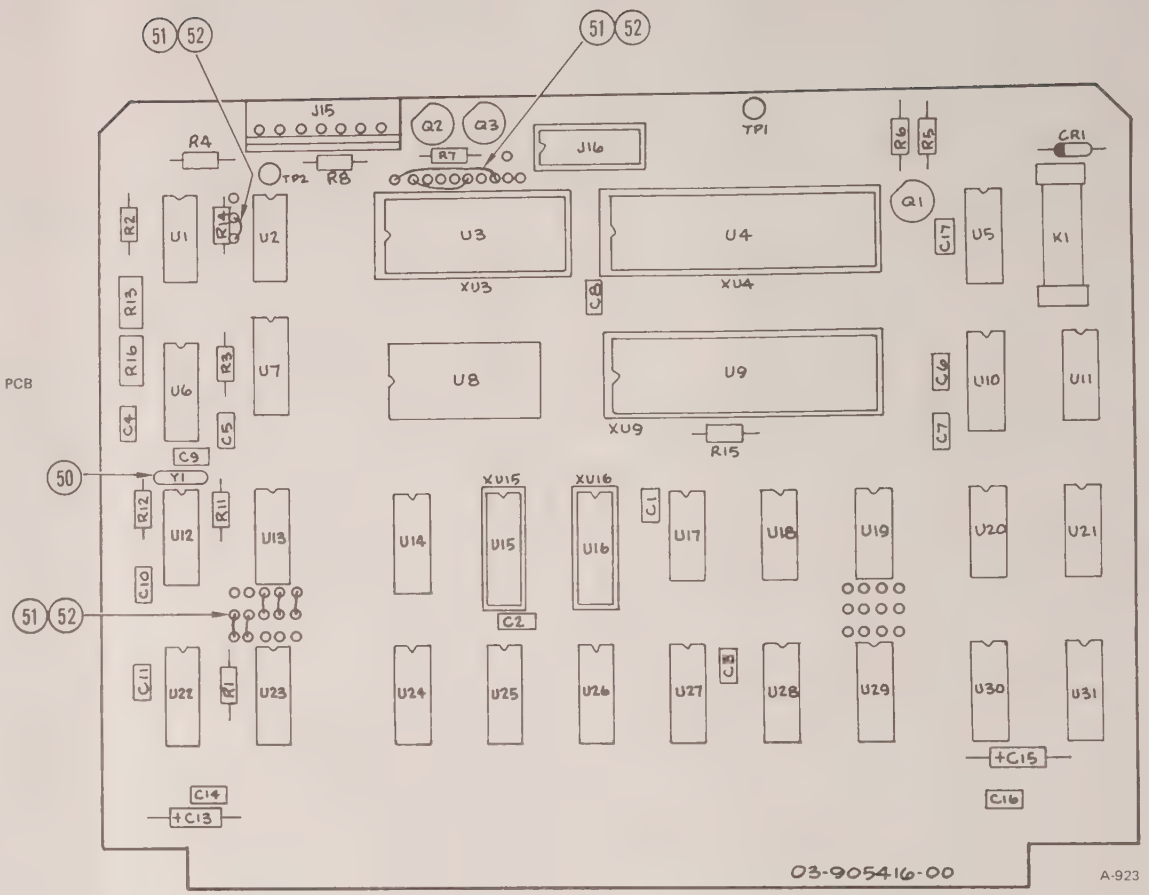


CPU PC BOARD ASSEMBLY DRAWING 03-905353-00

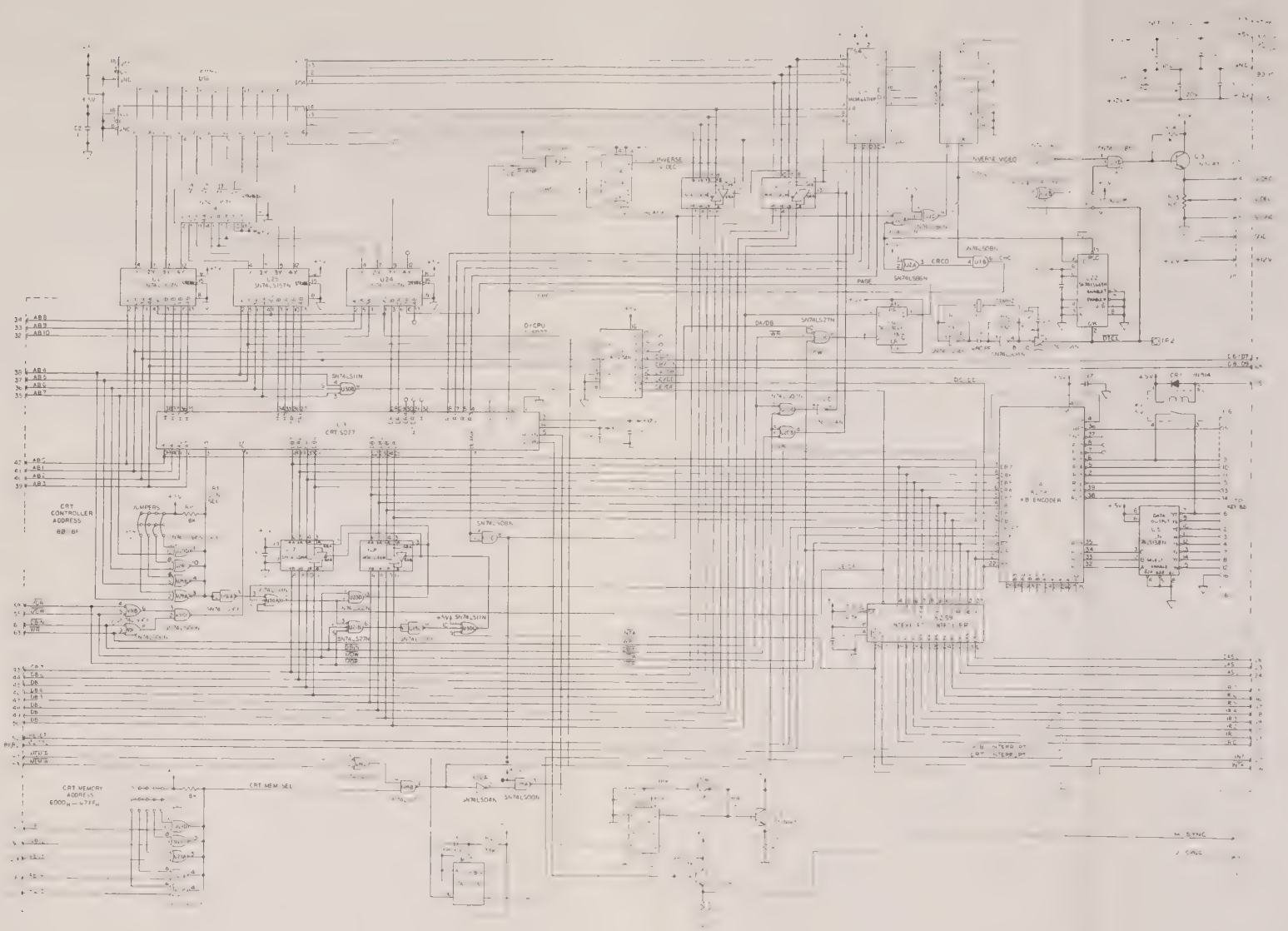


CPU PC BOARD SCHEMATIC DIAGRAM
03-905350-00

Schematic Reference/ Item No.	Part Number	Description
C1	05-000027-00	Capacitor, Ceramic 0.1 μF, 50V 20%
C2, C3		Same as C1
C4	41-229934-00	Capacitor, Ceramic 6800 pF, 200V 10%
C5	41-229518-00	Capacitor, Ceramic 680 pF, 100V 5%
C6-C8		Same as C1
C9		Same as C5
C10, C11		Same as C1
C13	05-000494-00	Capacitor, Tant 39 μF 10V, 10%
C14		Same as C1
C15	05-000250-00	Capacitor, Tant 10 μF 20V, 20%
C16, C17		Same as C1
CR1	14-000042-00	Diode, 1N914
J15	51-407101-00	Connector, Molex, 7 pin male
J16	54-634023-00	Socket, IC, 16 pins
K1	48-000572-00	Relay, Dry Reed, Form A
Q1	62-903643-00	Transistor, 2N3643
Q2, Q3		Same as Q1
R1	32-301418-00	Resistor, CC 1.8K 1/4W 5%
R2	32-301533-00	Resistor, CC 33K 1/4W 5%
R3	32-301518-00	Resistor, CC 18K 1/4W 5%
R4	32-301410-00	Resistor, CC 1K 1/4W 5%
R5	32-301433-00	Resistor, CC 3.3K 1/4W 5%
R6	32-301347-00	Resistor, CC 470Ω 1/4W 5%
R7		Same as R4
R8	32-301447-00	Resistor, CC 4.7K 1/4W 5%
R11	32-301333-00	Resistor, CC 330Ω 1/4W 5%
R12		Same as R11
R13	36-797882-00	Potentiometer, 100Ω
R14		Same as R4
R15		Same as R1
R16	36-797883-00	Potentiometer, 50K
U1	62-600717-00	IC, SN74LS08N
U2	62-600074-00	IC, SN74LS86N
U3	62-600892-00	IC, P8259
U4	62-600975-00	IC, P8279
U5	62-600063-00	IC, SN74LS138N
U6	62-600725-00	IC, SN74LS123N
U7	62-600836-00	IC, SN74LS166N
U8	62-600973-00	IC, MCM66714P
U9	62-601000-00	IC, CRT5027
U10		Same as U5
U11	62-600714-00	IC, SN74LS74AN
U12	62-600068-00	IC, SN74LS04N
U13	62-600885-00	IC, SN74LS266N
U14	62-600722-00	IC, SN74LS157N
U15	62-600964-00	IC, P2114L
U16		Same as U15
U17	62-600971-00	IC, SN74LS243N
U18		Same as U17
U19	62-600072-00	IC, SN74LS00N
U20	62-600712-00	IC, SN74LS02N
U21	62-600720-00	IC, SN74LS27N
U22	62-600992-00	IC, SN74LS669N
U23		Same as U13
U24-U26		Same as U14
U27, U28		Same as U17
U29		Same as U13
U30	62-600887-00	IC, SN74LS11N
U31		Same as U19
XU3	54-634057-00	Socket, IC, 28 pins
XU4	54-634058-00	Socket, IC, 40 pins
XU9		Same as XU4
XU15	54-634032-00	Socket, IC, 18 pins
XU16		Same as XU15
Y1	66-472006-00	Crystal, 7.074 MHz
	03-905415-00	CRT & Int Cont. Keyboard Interface PCB
	25-000161-00	Handle, Card Ejector
50	22-399540-00	Cap Mount
51	24-000411-00	Tubing, Teflon 22 GA
52	59-000008-00	Wire, Copper 22 GA

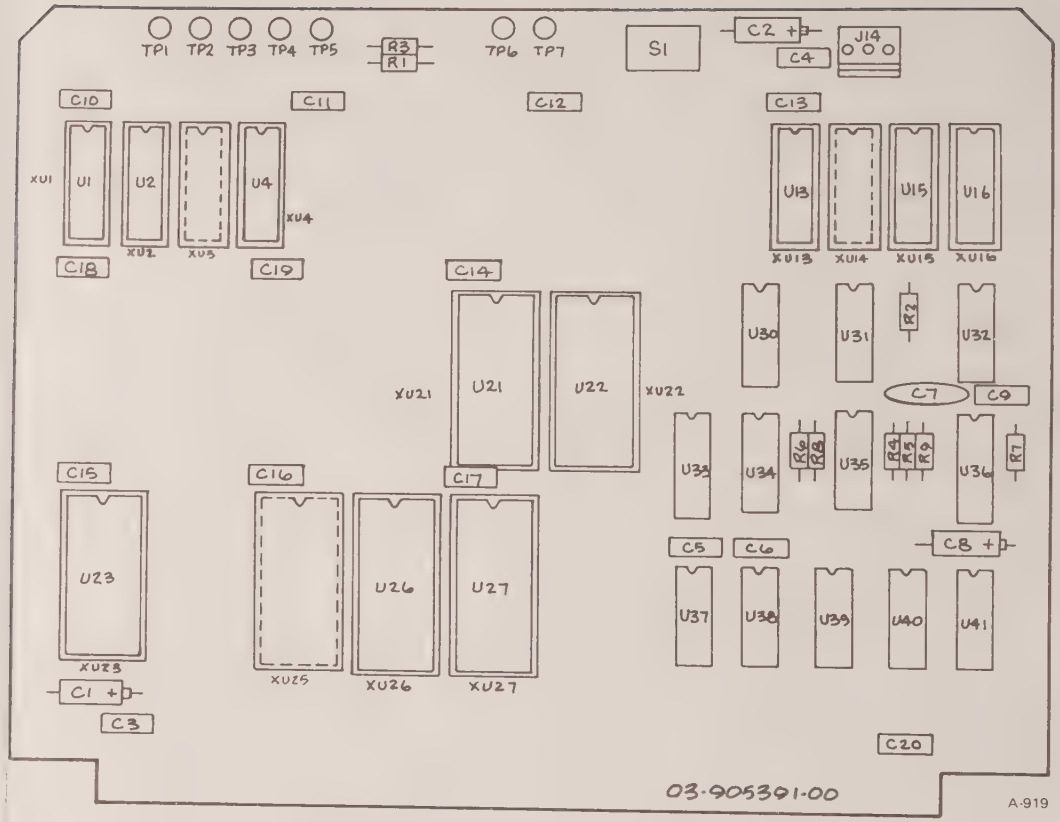


CRT & INTERRUPT CONTROLLER PC BOARD ASSEMBLY DRAWING 03-905416-00

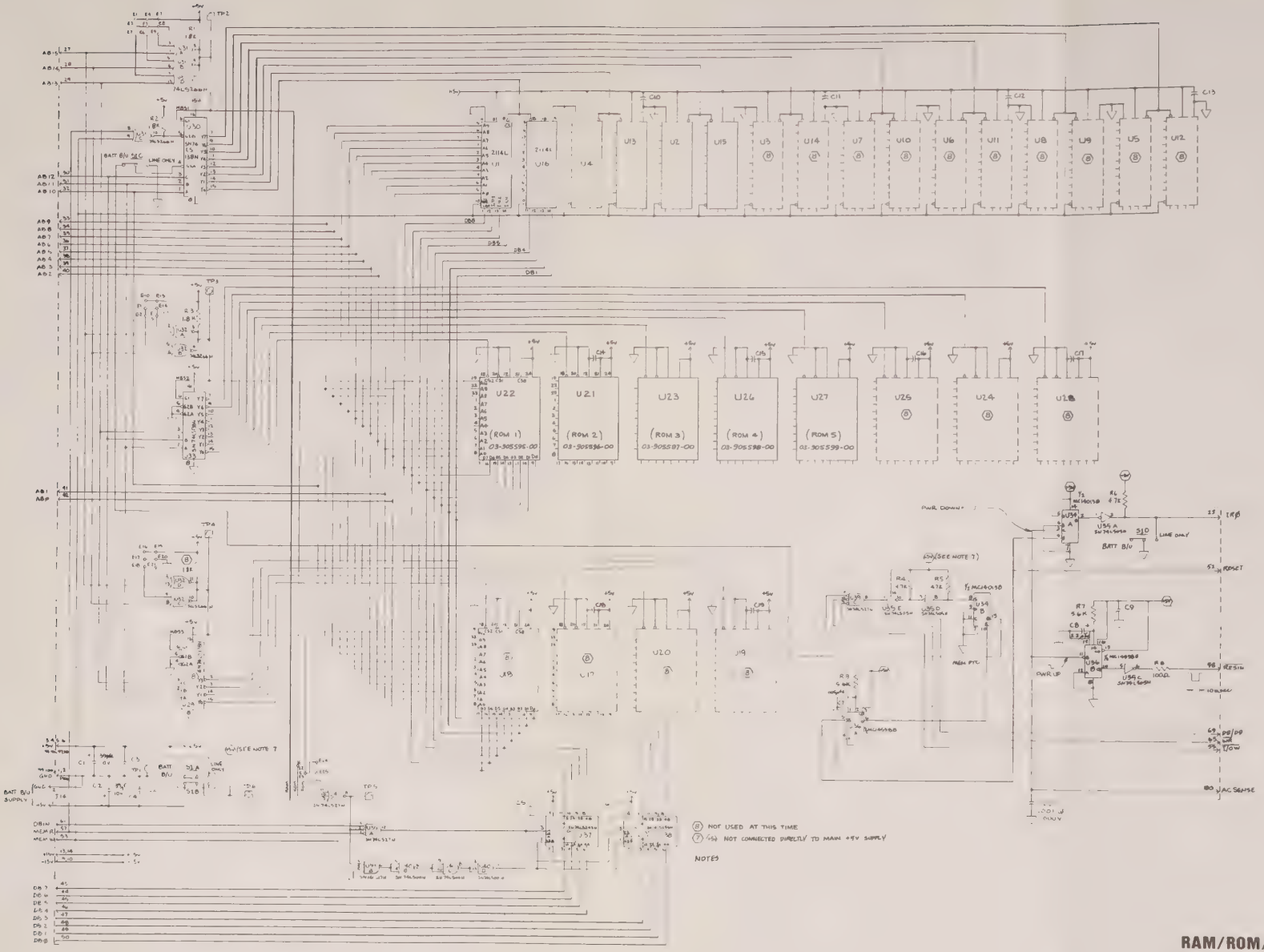


CRT & INTERRUPT CONTROLLER PC BOARD
SCHEMATIC DIAGRAM 03-905413-00

Schematic Reference/ Item No.	Part Number	Description
C1	05-000494-00	Capacitor, Tant 39 µF 10V
C2		Same as C1
C3	05-000027-00	Capacitor, Ceramic .1 µF 50V
C4-C6		Same as C3
C7	41-264880-00	Capacitor, Cer. Disc .005 µF 500V
C8	05-000284-00	Capacitor, Tant 2.2 µF 35V
C9-C19		Same as C3
C20	05-000001-00	Capacitor, Cer. Disc. .001 µF 1000V
J14	51-407023-00	Connector, Molex PC 3 pin
R1	39-000376-00	Resistor, CC 1.8K 1/4W 5%
R2, 3		Same as R1
R4	39-000377-00	Resistor, CC 4.7K 1/4W 5%
R5, 6		Same as R4
R7	39-000979-00	Resistor, CC 5.6K 1/4W 5%
R8	39-000069-00	Resistor, CC 100Ω 1/4W 5%
R9		Same as R7
S1	71-349801-00	Switch, Slide 4SPDT
U1	62-600964-00	IC, P2114L
U2, U4, U13, U15, U16		Same as U1
U21	03-905596-00	IC, 8316E (ROM 2)
U22	03-905595-00	IC, 8316E (ROM 1)
U23	03-905597-00	IC, 8316E (ROM 3)
U26	03-905598-00	IC, 8316E (ROM 4)
U27	03-905599-00	IC, 8316E (ROM 5)
U30	62-600063-00	IC, SN74LS138N
U31	62-600885-00	IC, SN74LS266N
U32		Same as U31
U33		Same as U30
U34	62-600003-00	IC, MC14013B
U35	62-601010-00	IC, SN74LS05N
U36	62-601011-00	IC, MC14538B
U37	62-600971-00	IC, SN74LS243N
U38		Same as U37
U39	62-600720-00	IC, SN74LS27N
U40	62-600072-00	IC, SN74LS00N
U41		Same as U39
XU1	54-634032-00	Socket, IC, 18 pin Dip
XU2-XU4		Same as XU1
XU13-XU16		Same as XU1
XU21	54-634012-00	Socket, IC, 24 pin Dip
XU22, XU23		Same as XU21
XU25-XU27		Same as XU21
	03-905390-00	RAM/ROM/PROM PCB
	25-000161-00	Handle, Card Ejector



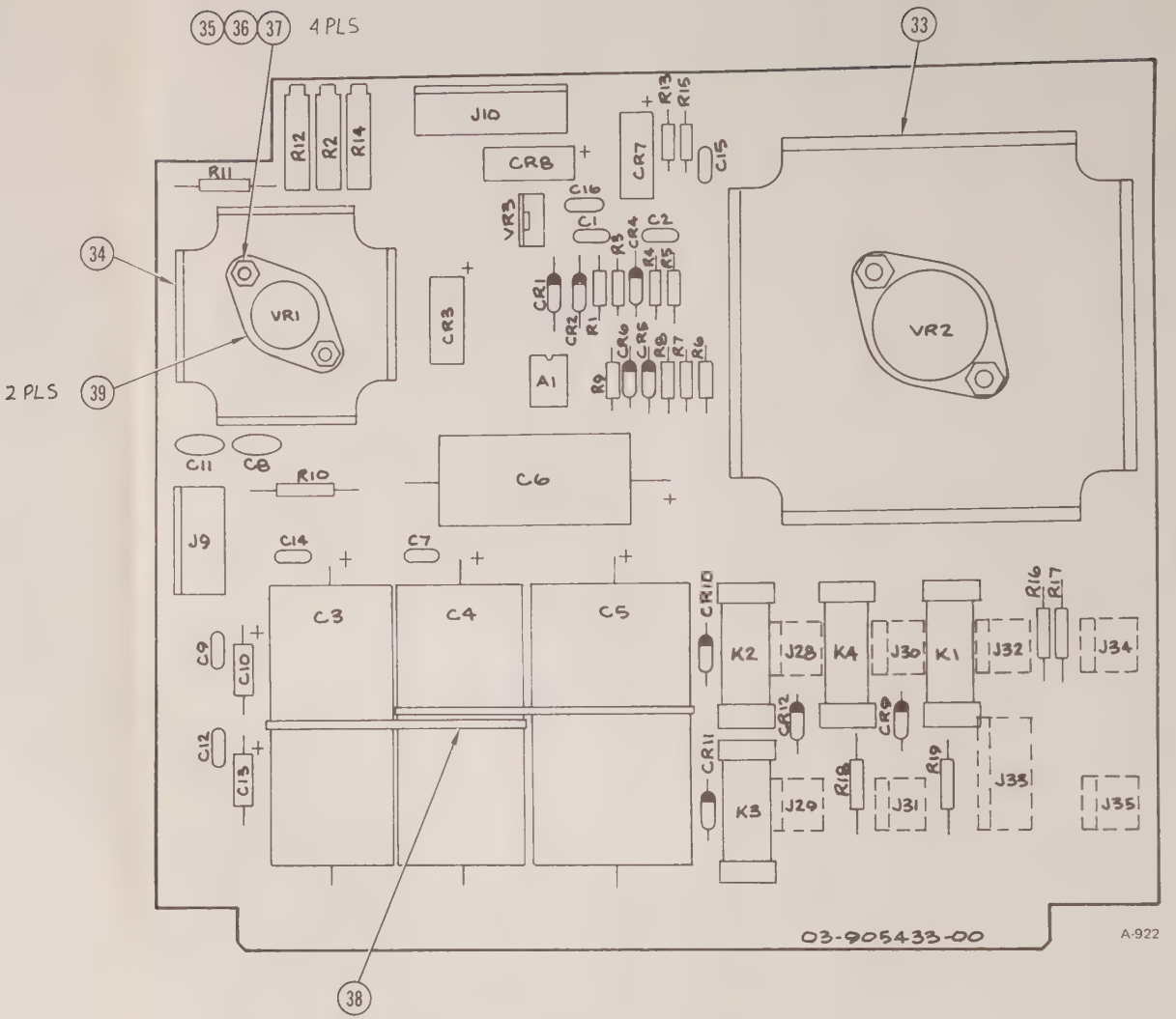
RAM/ROM/PROM PC BOARD ASSEMBLY DRAWING 03-905391-00


U22 (ROM 1) 03-905595-00
U21 (ROM 2) 03-905596-00
U23 (ROM 3) 03-905597-00
U26 (ROM 4) 03-905598-00
U27 (ROM 5) 03-905599-00
NOT USED AT THIS TIME
NOT CONNECTED DIRECTLY TO MAIN +5V SUPPLY
NOTES

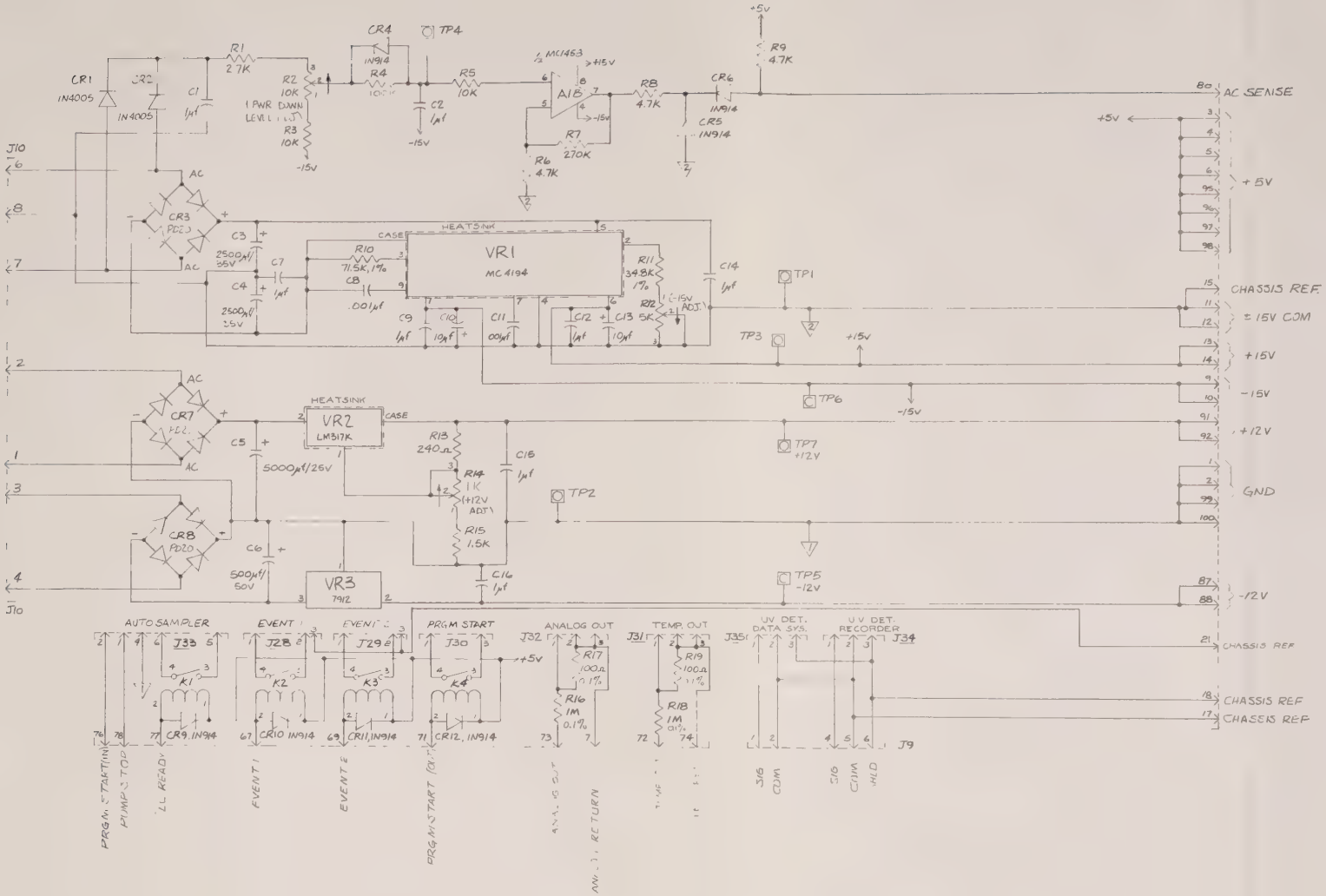
RAM/ROM/PROM PC BOARD
SCHEMATIC DIAGRAM 03-905388-00

Schematic Reference/ Item No.	Part Number	Description
A1	62-600223-00	Amplifier, MC1458L
C1	05-000028-00	Capacitor, Ceramic 1 μF, 50V
C2		Same as C1
C3	41-505815-00	Capacitor, Elect. 2500 μF, 35V
C4		Same as C3
C5	41-505820-00	Capacitor, Elect. 5000 μF, 25V
C6	05-000417-00	Capacitor, Elect. 500 μF, 50V
C7		Same as C1
C8	05-000001-00	Capacitor, Ceramic .001 μF, 1 kV
C9		Same as C1
C10	05-000250-00	Capacitor, Tant 10 μF, 20V
C11		Same as C8
C12		Same as C1
C13		Same as C10
C14-C16		Same as C1
CR1	14-000018-00	Diode, TS1 (1N4002)
CR2		Same as CR1
CR3	00-908047-01	Diode, Rect. Bridge, PD20
CR4	14-000042-00	Diode, 1N914
CR5, CR6		Same as CR4
CR7, CR8		Same as CR3
CR9-CR12		Same as CR4
J9	51-407100-00	Connector, Molex, 6 pin Male
J10	51-407102-00	Connector, Molex, 8 pin Male
J28	51-407023-00	Connector, Molex, 3 pin Male
J29-J32		Same as J28
J33		Same as J9
J34, J35		Same as J28
K1	48-000572-00	Relay, Dry Reed, Elect. form A
K2-K4		Same as K1
R1	39-000374-00	Resistor, CC 2.7K 1/4W 5%
R2	39-000605-00	Potentiometer, 10K, 15 Turn
R3	32-301510-00	Resistor, CC 10K 1/4W 5%
R4	32-301610-00	Resistor, CC 100K 1/4W 5%
R5		Same as R3
R6	32-301447-00	Resistor, CC 4.7K 1/4W 5%
R7	32-301627-00	Resistor, CC 270K 1/4W 5%
R8, R9		Same as R6
R10	31-614656-00	Resistor, MF 71.5K 1/4W 1%
R11	31-614662-00	Resistor, MF 34.8K 1/4W 1%
R12	39-000592-00	Potentiometer, 5K 15 Turn
R13	32-301324-00	Resistor, CC 240Ω 1/4W 5%
R14	39-000621-00	Potentiometer, 1K 15 Turn
R15	39-000392-00	Resistor, CC 1.5K 1/4W 5%
R16	31-614801-00	Resistor, MF 1M 1/4W 0.1%
R17	31-616018-00	Resistor, MF 100Ω 1/4W 0.1%
R18		Same as R16
R19		Same as R17
VR1	62-600485-00	Regulator, MC4194
VR2	62-600844-00	Regulator, LM317K
VR3	62-600483-00	Regulator, MC7912

	03-905432-00	Regulator PCB
33	66-899888-00	Heatsink, TO-3
34	66-899891-00	Heatsink, TO-66
35	12-222006-00	Screw, 6-32 x 7/16 PH, SS
36	13-310000-00	Nut, Kep 6-32 Sm Patt
37	15-000721-00	Washer, 6 Brass
38	22-119699-00	Tie, Cable, 11" Long
39	82-005750-00	Heatsink Compound

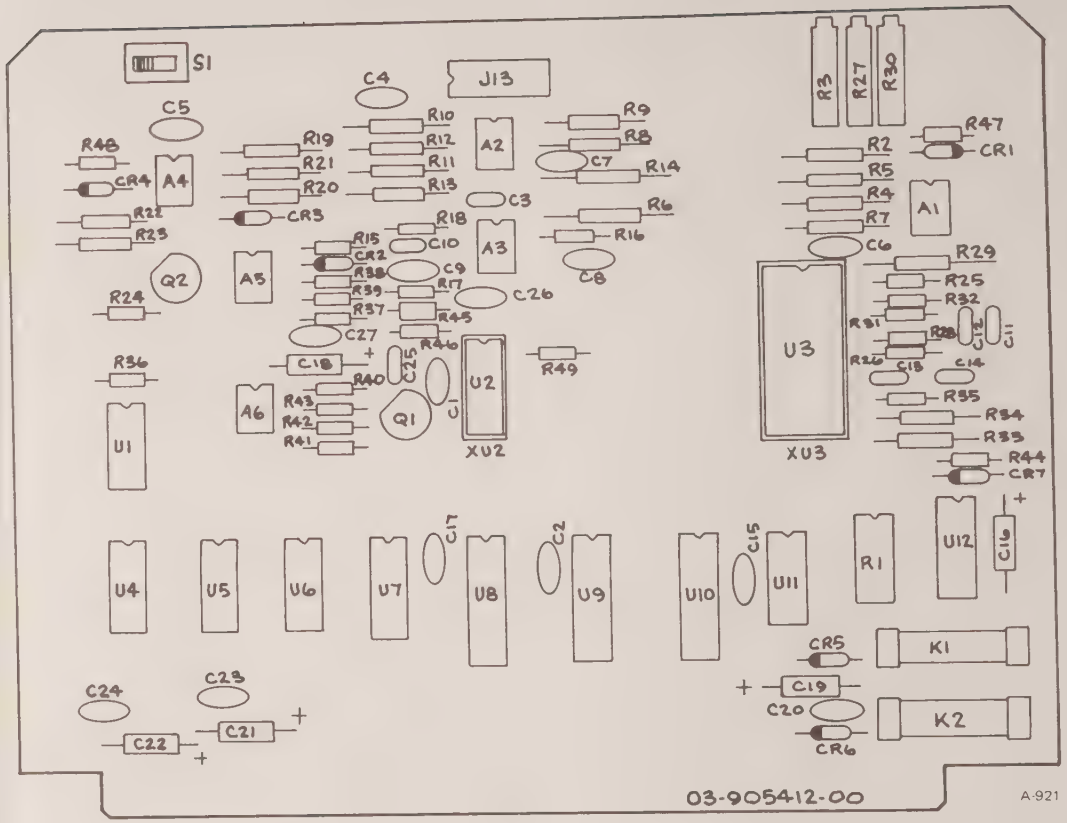


REGULATOR PC BOARD ASSEMBLY DRAWING 03-905433-00

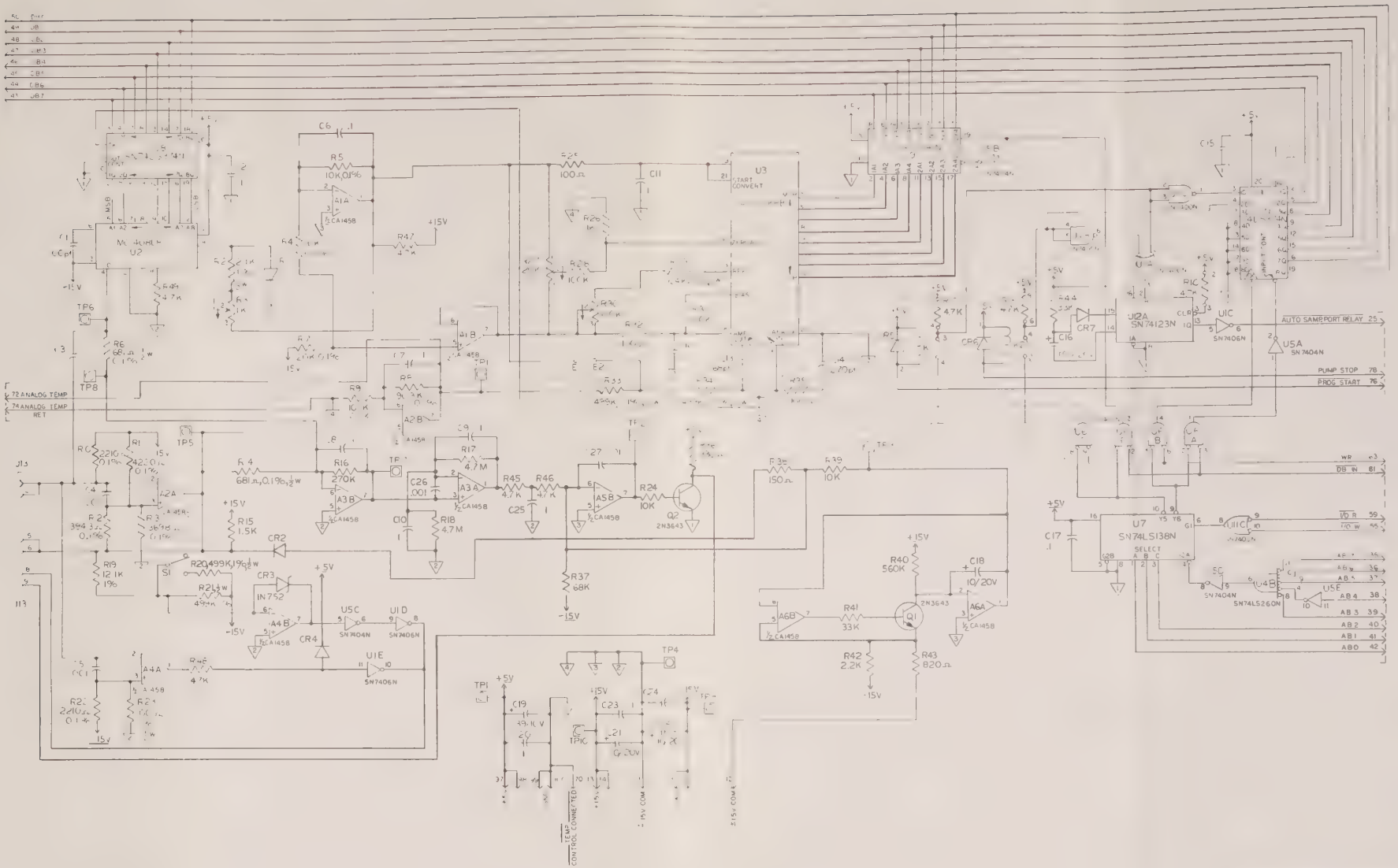


REGULATOR PC BOARD
SCHEMATIC DIAGRAM 03-905430-00

Schematic Reference/ Item No.	Part Number	Description
A1	62-600223-00	Amplifier, MC1458L
A2-A6		Same as A1
C1	05-000025-00	Capacitor, Mica 100 pF 300V
C2	05-000027-00	Capacitor, Ceramic .1 µF 50V
C3	05-000028-00	Capacitor, Ceramic 1 µF 50V
C4	05-000001-00	Capacitor, Ceramic .001 µF 50V
C5		Same as C4
C6-C9		Same as C2
C10-C12		Same as C3
C13	41-159562-00	Capacitor, Mica 68 pF 50V
C14	41-229987-00	Capacitor, Ceramic 270 pF 50V
C15		Same as C2
C16	05-000250-00	Capacitor, Tant 10 µF 20V
C17		Same as C2
C18		Same as C16
C19	05-000494-00	Capacitor, Tant 39 µF 10V
C20		Same as C2
C21, C22		Same as C16
C23, C24		Same as C2
C25		Same as C3
C26		Same as C4
C27	05-000029-00	Capacitor, Ceramic .01 µF 100V
CR1	14-000042-00	Diode, 1N914
CR2		Same as CR1
CR3	14-000043-00	Diode, Zener, 1N752A
CR4-CR7		Same as CR1
J13	54-634023-00	Socket, IC, 16 Pin Dip
K1	48-000572-00	Relay, Dry Reed, Form A
K2		Same as K1
Q1	14-000508-00	Transistor, 2N3643
Q2		Same as Q1
R1	39-001070-00	Resistor Network, 4.7K, 7 Res
R2	31-615210-00	Resistor, MF 2.1K 1/2W 5%
R3	39-000621-00	Potentiometer, 1K, 89PR1K
R4	31-616021-00	Resistor, MF 10K 1/4W 0.1%
R5		Same as R4
R6	31-698999-00	Resistor, MF 681Ω 1/2W 0.1%
R7	31-613206-00	Resistor, MF 20K 1/4W 0.1%
R8	31-614821-00	Resistor, MF 90.9K 1/8W 0.1%
R9	31-616009-00	Resistor, MF 10.1K 1/4W 0.1%
R10	31-616016-00	Resistor, MF 2.21K 1/4W 0.1%
R11	31-616114-00	Resistor, MF 4.22K 1/4W 0.1%
R12	31-616115-00	Resistor, MF 394.3Ω 1/4W 0.1%
R13	31-616116-00	Resistor, MF 369.8Ω 1/4W 0.1%
R14		Same as R6
R15	39-000392-00	Resistor, CC 1.5K 1/4W 5%
R16	32-301627-00	Resistor, CC 270K 1/4W 5%
R17	32-301747-00	Resistor, CC 4.7M 1/4W 5%
R18		Same as R17
R19	39-000256-00	Resistor, MF 12.1K 1/4W 1%
R20	31-614671-00	Resistor, MF 499K 1/4W 1%
R21		Same as R20
R22		Same as R10
R23	39-000092-00	Resistor, MF 100Ω 1/2W 1%
R24	39-000369-00	Resistor, CC 10K 1/4W 5%
R25	32-301310-00	Resistor, CC 100Ω 1/4W 5%
R26	39-000419-00	Resistor, CC 1K 1/4W 5%
R27	39-000612-00	Potentiometer, 20K, 89PR20K
R28	39-000978-00	Resistor, CC 100K 1/4W 5%
R29	39-000286-00	Resistor, MF 124K 1/2W 1%
R30	39-000594-00	Potentiometer, 100K, 89PR100K
R31		Same as R28
R32		Same as R25
R33, R34		Same as R20
R35		Same as R25
R36	32-302333-00	Resistor, CC 330Ω 1/4W 5%
R37	39-000941-00	Resistor, CC 68K 1/4W 5%
R38	39-000370-00	Resistor, CC 150Ω 1/4W 5%
R39		Same as R24
R40	32-301656-00	Resistor, CC 560K 1/4W 5%
R41	39-000383-00	Resistor, CC 33K 1/4W 5%
R42	39-000371-00	Resistor, CC 2.2K 1/4W 5%
R43	32-301382-00	Resistor, CC 820Ω 1/4W 5%
R44		Same as R41
R45	32-301447-00	Resistor, CC 4.7K 1/4W 5%
R46-R49		Same as R45
S1	71-349901-00	Switch, PC Mtg
U1	14-000590-00	IC, SN7406N
U2	62-600049-00	IC, MC1408L8
U3	62-600924-00	IC, ADC-EK8B
U4	62-600792-00	IC, SN74S260N
U5	14-000634-00	IC, SN7404N
U6	14-000571-00	IC, SN7402N
U7	62-600063-00	IC, SN74LS138N
U8	62-600900-00	IC, SN74LS374N
U9	62-600874-00	IC, SN74LS241N
U10		Same as U8
U11	14-000548-00	IC, SN7400N
U12	62-600297-00	IC, SN74123N
XU2	44-000045-00	Socket, IC, 16 Pin Dip
XU3	54-634012-00	Socket, IC, 24 Pin Dip
1	03-905411-00	Temp. Controller PCB
62	25-000161-00	Handle, Card Ejector

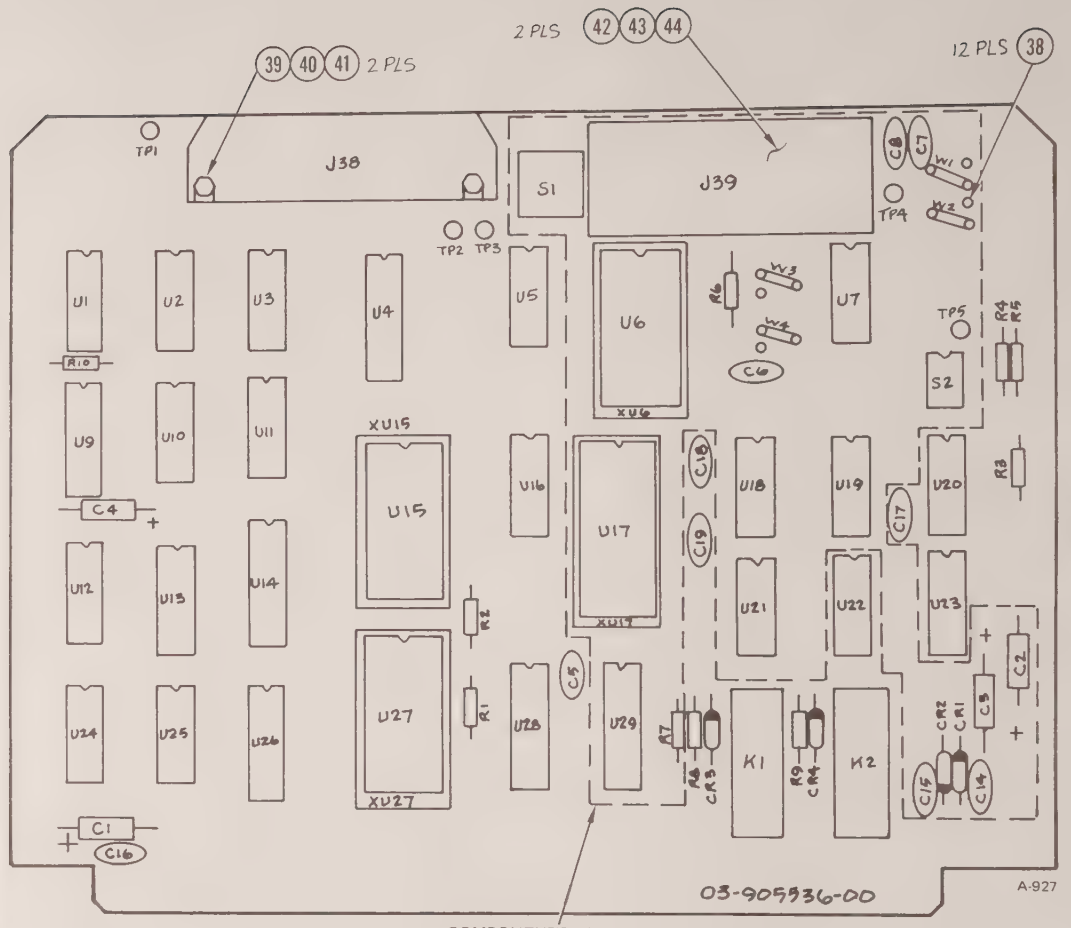


TEMPERATURE CONTROLLER PC BOARD ASSEMBLY DRAWING 03-905412-00

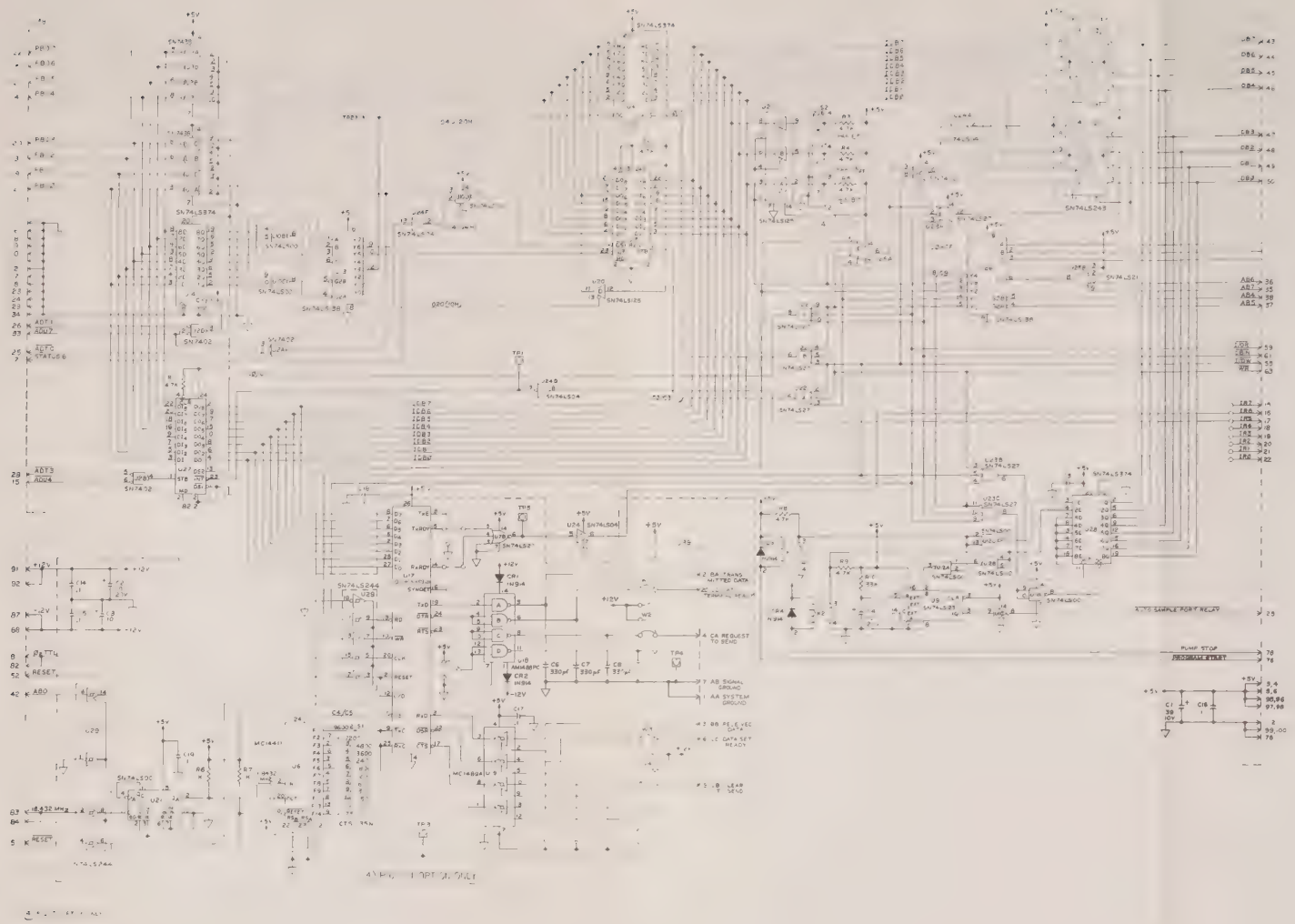


TEMPERATURE CONTROLLER PC BOARD
SCHEMATIC DIAGRAM 03-905409-00

Schematic Reference/ Item No.	Part Number	Description
C1	05-000494-00	Capacitor, 39 µF 10V
C2	05-000250-00	Capacitor, 10 µF 20V
C3, C4		Same as C2
C5	05-000027-00	Capacitor, .1 µF 50V
C6	41-159510-00	Capacitor, Mica 330 pF 500V
C7, C8		Same as C6
C14-C19		Same as C5
CR1	14-000042-00	Diode, 1N914
CR2-CR4		Same as CR1
J38	51-108859-00	Connector, 3M 3431-1002
J39	51-340002-00	Connector, Cannon DB-25PA
K1	48-000572-00	Relay, Dry Reed, Form A
K2		Same as K1
R1	32-301447-00	Resistor, CC 4.7K 1/4W 5%
R2-R5		Same as R1
R6	32-301410-00	Resistor, CC 1K 1/4W 5%
R7		Same as R6
R8, R9		Same as R1
R10	32-301533-00	Resistor, CC 33K 1/4W 5%
S1	71-710052-00	Switch, CTS 235N
S2	71-996981-00	Switch, CTS 206-4
U1	14-000590-00	IC, SN7406N
U2	14-000571-00	IC, SN7402N
U3	62-600294-00	IC, SN7438N
U4	62-600900-00	IC, SN74LS374N
U5	62-600971-00	IC, SN74LS243N
U6	62-601079-00	IC, MC14411P
U7	62-600720-00	IC, SN74LS27N
U9	62-600725-00	IC, SN74LS123N
U10	62-600072-00	IC, SN74LS00N
U11		Same as U3
U12		Same as U10
U13	62-600063-00	IC, SN74LS138N
U14		Same as U4
U15	62-600857-00	IC, P8212
U16		Same as U5
U17	03-905359-00	IC, AM9551
U18	62-601081-00	IC, AM1488PC
U19	62-600872-00	IC, UA1489APC
U20	62-601131-00	IC, SN74LS125N
U21	62-601107-00	IC, SN74LS90N
U22, U23		Same as U7
U24	62-600068-00	IC, SN74LS04N
U25	62-601049-00	IC, SN74LS21N
U26		Same as U13
U27		Same as U14
U29	62-601018-00	IC, SN74LS244N
W1	51-452934-00	Plug, Shorting, Insulated
W2-W4		Same as W1
XU6	54-634012-00	Socket, IC 24 pins
XU15		Same as XU6
XU17	54-634057-00	Socket, IC 28 pins
XU27		Same as XU6
	03-905537-00	Options PC Board
38	51-451714-00	Jacks
39	14-122003-00	Washer, Plain #3 SS
40	12-222002-06	Screw, 2-56 x 3/8 Ph Phil, SS
41	13-122002-00	Nut, Hex 2-56, SS
42	14-122004-00	Washer, Plain #4, SS
43	12-222004-06	Screw, 4-40 x 3/8 Ph Phil, SS
44	13-311104-00	Nut, Kep 4-40, SS
	25-000161-00	Handle, Card Ejector

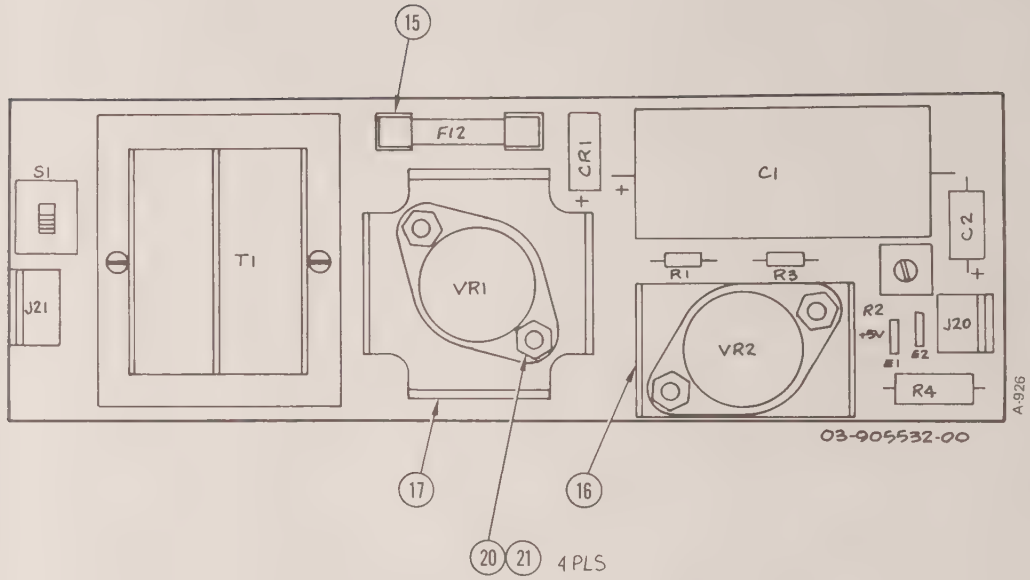


OPTION PC BOARD ASSEMBLY DRAWING
03-905536-00

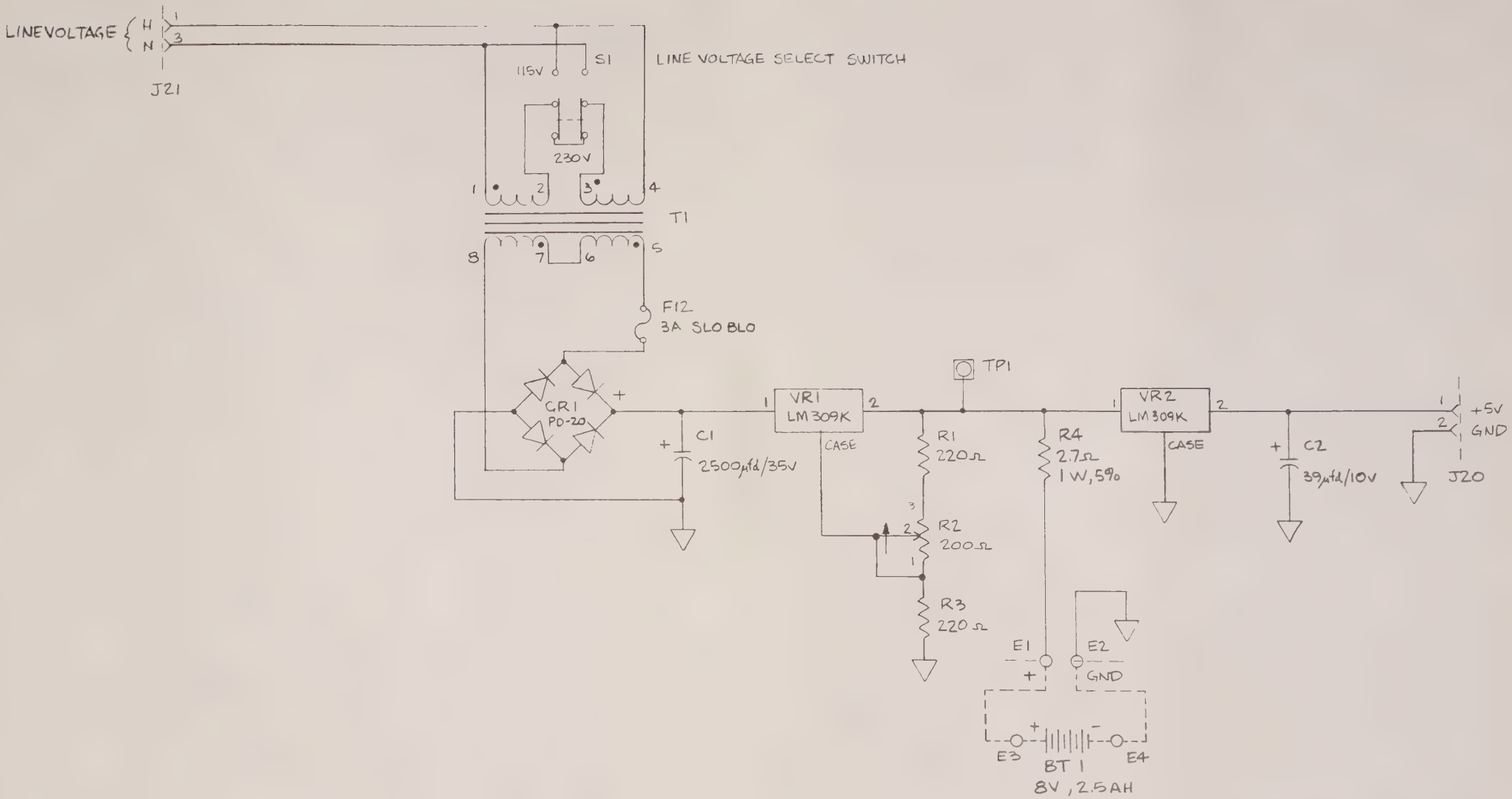


OPTION PC BOARD SCHEMATIC DIAGRAM
03-905539-00

Schematic Reference/ Item No.	Part Number	Description
C1	41-505815-00	Capacitor, 2500 µF, 135V
C2	41-606935-00	Capacitor, Tant 39 µF 110V
CR1	00-908407-00	Diode, Bridge, PD20
E1	51-451503-00	Tab, Quik-Disconnect, 3/16"
E2	51-451504-00	Tab, Quik-Disconnect, 1/4"
F12	67-129006-00	Fuse, 3A Slo-Blo
J20	51-407023-00	Connector, Molex 3 pin male
J21	51-407024-00	Connector, Molex, 4 pin male
R1	39-000380-00	Resistor, CC 220Ω 1/4W 5%
R2	39-000625-00	Potentiometer 200Ω 1 Turn
R3		Same as R1
R4	33-301127-00	Resistor, CC 2.7Ω 1W 5%
S1	71-349809-00	Switch, Slide, DPDT
T1	44-149035-00	Transformer
VR1	62-600498-00	Regulator, LM309K
VR2		Same as VR1
	03-905533-00	RAM Power Supply & Batt. Back-up PCB
15	51-649991-00	Clip, Fuse Holder
16	66-899996-00	Heatsink, TO-3
17	66-899960-00	Heatsink, UP-TO-3
20	12-222006-00	Screw, 6-32 x 7/16 Ph Hd SS
21	13-310000-00	Nut, Kep 6-32 Sm Patt

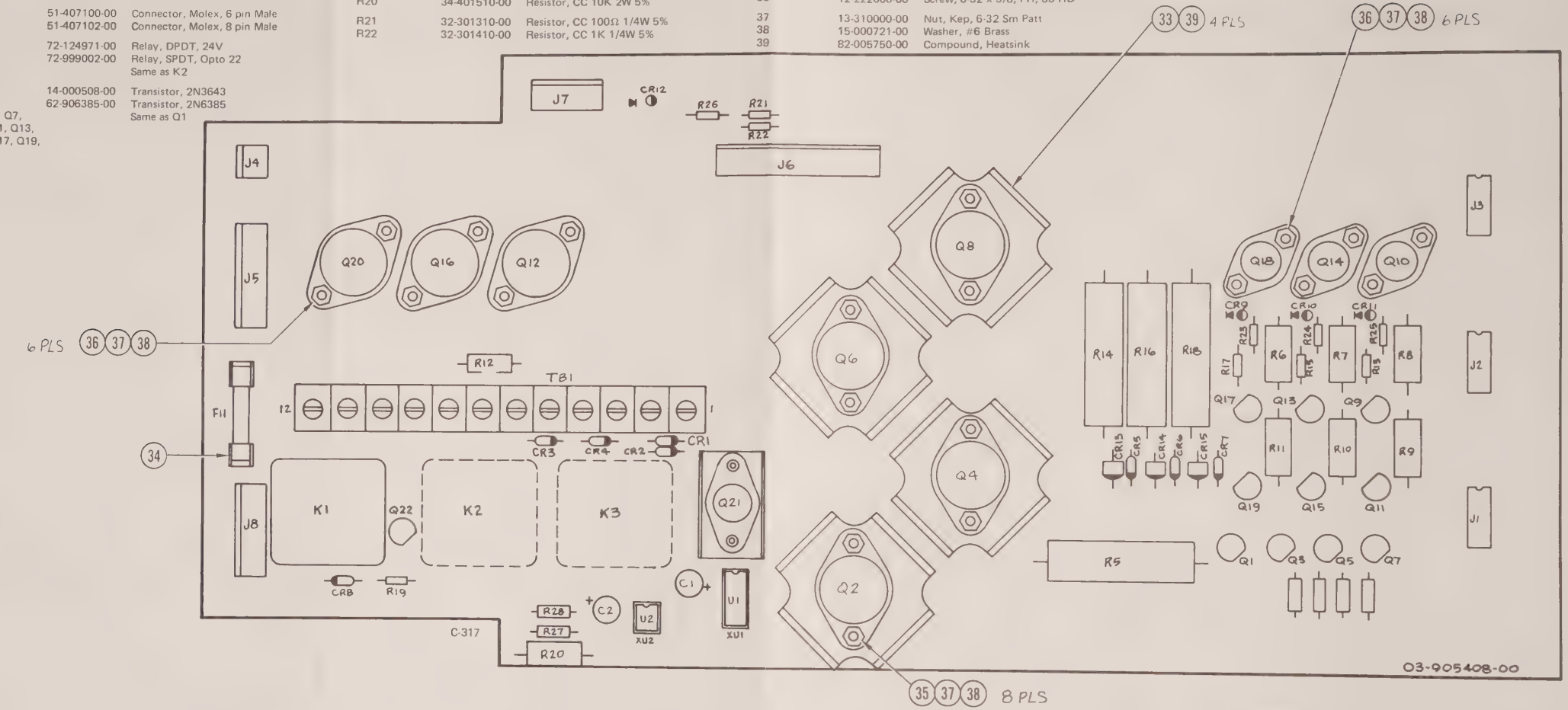


RAM POWER SUPPLY & BATTERY BACK-UP
ASSEMBLY DRAWING 03-905532-00

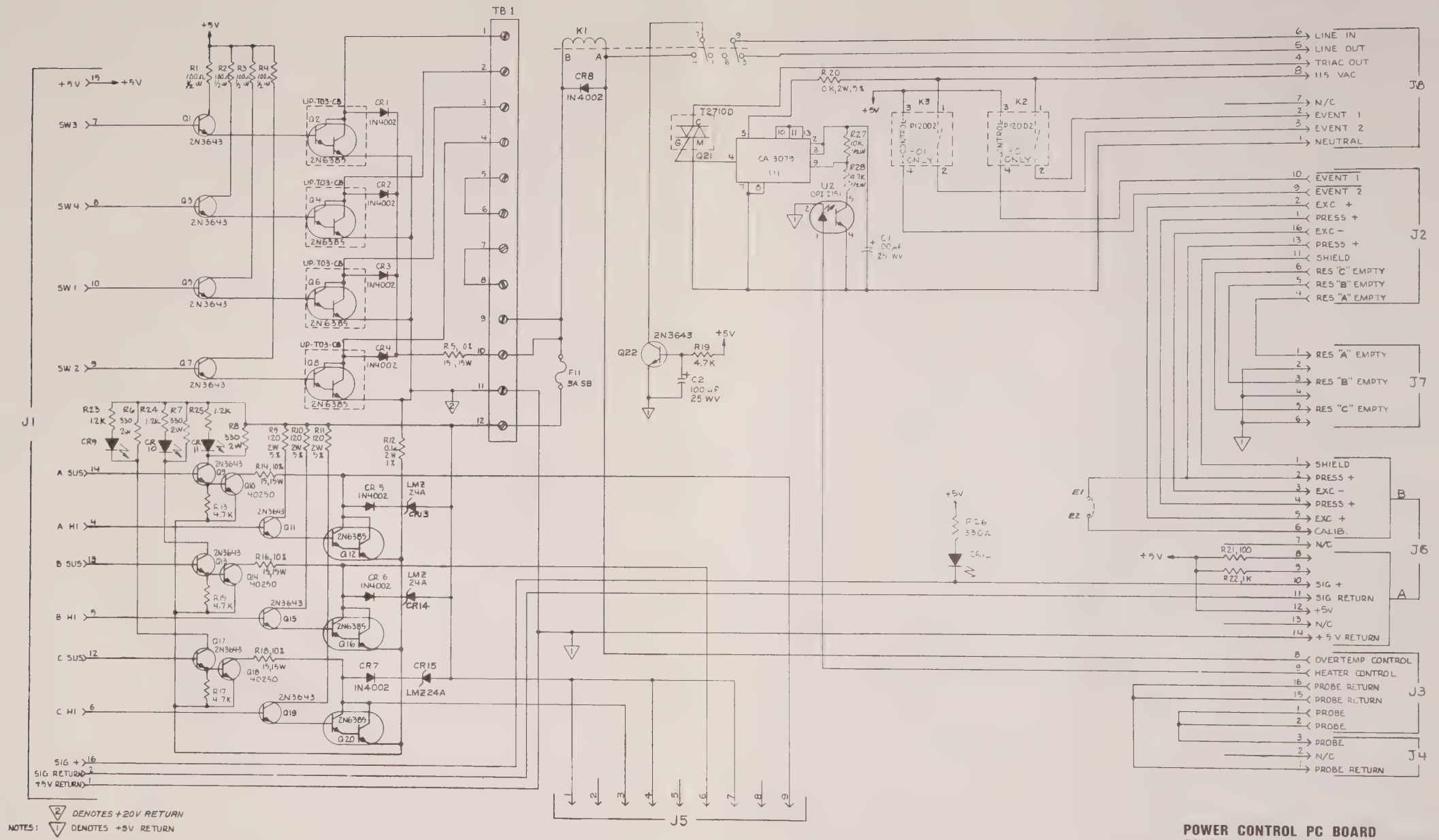


RAM POWER SUPPLY & BATTERY BACK-UP PC BOARD
SCHEMATIC DIAGRAM 03-905535-00

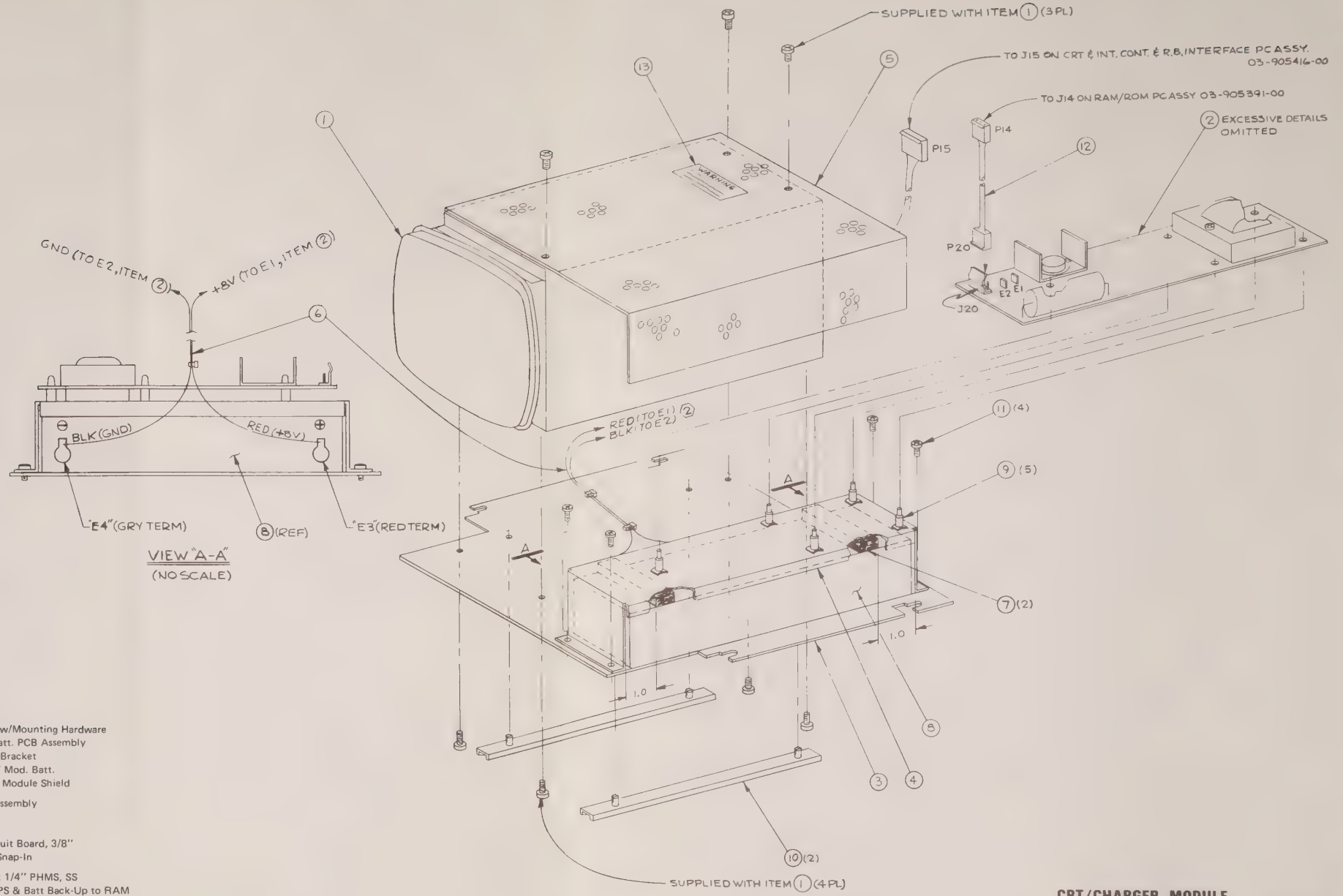
Schematic Reference/ Item No.		
C1	05-000497-00	Capacitor, Elect, 100 mF 25V
C2		Same as C1
CR1-CR8	14-000018-00	Diode, 1N4002
CR9-CR12	56-000543-00	Diode, Led
CR13-CR15	14-000016-00	Diode, Zener, LMZ24A
F11	19-000016-00	Fuse, 3A Slow-Blow
J1	54-634023-00	Socket, IC, 16 pin Dip
J2, J3		Same as J1
J4	51-407023-00	Connector, Molex, 3 pin Male
J5	51-407108-00	Connector, Molex, 9 pin Male
J6	51-407109-00	Connector, Molex, 14 pin Male
J7	51-407100-00	Connector, Molex, 6 pin Male
J8	51-407102-00	Connector, Molex, 8 pin Male
K1	72-124971-00	Relay, DPDT, 24V
K2	72-999002-00	Relay, SPDT, Opto 22
K3		Same as K2
Q1	14-000508-00	Transistor, 2N3643
Q2	62-906385-00	Transistor, 2N6385
Q3, Q5, Q7, Q9, Q11, Q13, Q15, Q17, Q19, Q22		Same as Q1
Q4, Q6, Q8, Q12, Q16, Q20		Same as Q2
Q10	62-799055-00	Transistor, 40250
Q14, Q18		Same as Q10
Q21	66-650011-00	Triac, T2710D
R1	32-201310-00	Resistor, CC 100Ω 1/2W 5%
R2-R4		Same as R1
R5	31-588579-00	Resistor, WW 15Ω 15W 10%
R6-R8	34-401333-00	Resistor, CC 330Ω 2W 5%
R9-R11	34-401312-00	Resistor, CC 120Ω 2W 5%
R12	31-560100-00	Resistor, WW 0.1Ω 2W 1%
R13	32-301447-00	Resistor, CC 4.7K 1/4W 5%
R14, R16, R18		Same as R5
R15, R17, R19		Same as R13
R20	34-401510-00	Resistor, CC 10K 2W 5%
R21	32-301310-00	Resistor, CC 100Ω 1/4W 5%
R22	32-301410-00	Resistor, CC 1K 1/4W 5%
R23-R25	32-301412-00	Resistor, CC 1.2K 1/4W 5%
R26	32-301333-00	Resistor, CC 330Ω 1/4W 5%
R27	32-201510-00	Resistor, CC 10K 1/2W 5%
R28	32-201447-00	Resistor, CC 4.7K 1/2W 5%
TB1	51-000436-00	Terminal Block, 12 position
U1	62-600095-00	IC, Switch, CA3079
U2	66-599715-00	IC, Opt. Coupler, OPI-2151
XU1	44-000046-00	Socket, IC, 14 pin
XU2	54-634037-00	Socket, IC, 6 pin
	03-905407-00	Power Control PCB
33	66-899960-00	Heatsink, TO-3 Blk
34	19-000209-00	Clip, Fuse, Spring
35	12-222006-10	Screw, 6-32 x 5/8, PH, SS HD
36	12-222006-06	Screw, 6-32 x 3/8, PH, SS HD
37	13-310000-00	Nut, Kep, 6-32 Sm Patt
38	15-000721-00	Washer, #6 Brass
39	82-005750-00	Compound, Heatsink



POWER CONTROL PC BOARD ASSEMBLY DRAWING 03-905408-00

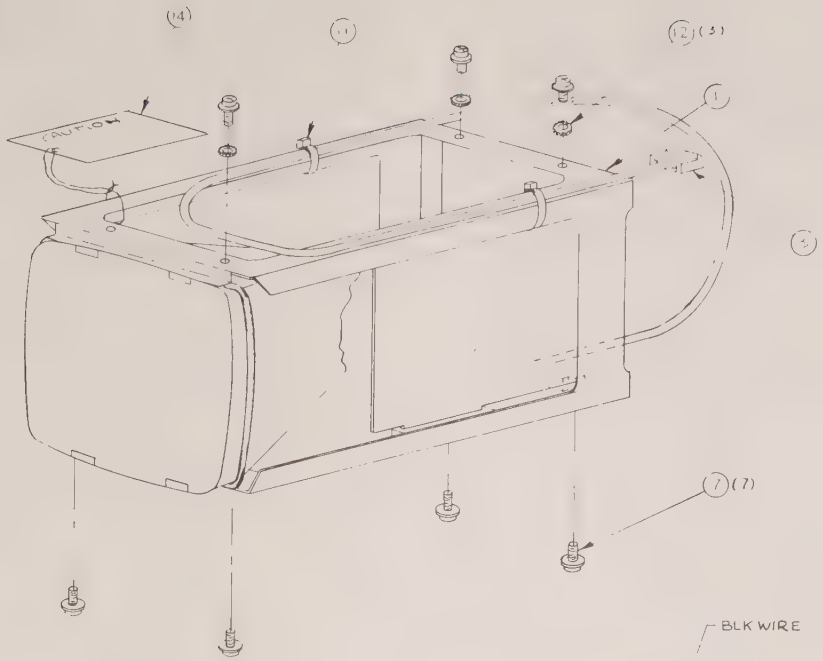


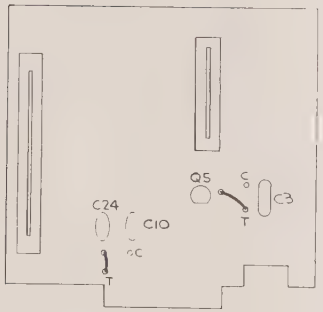
POWER CONTROL PC BOARD SCHEMATIC DIAGRAM 03-905405-00



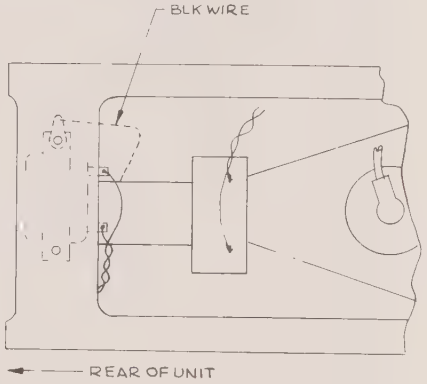
Schematic Reference/ Item No.	Part Number	Description
1	03-905614-00	CRT Module w/Mounting Hardware
2	03-905532-00	RAM PS & Batt. PCB Assembly
3	03-905564-00	CRT Module Bracket
4	03-905560-00	Bracket, CRT Mod. Batt.
5	03-905616-00	CRT/Charger Module Shield
6	03-905589-00	Batt. Cable Assembly
7	03-905613-00	Rubber Pad
8	74-103700-00	Battery, 8V
9	22-399509-00	Support, Circuit Board, 3/8"
10	22-319808-00	Card Guide, Snap-In
11	12-222008-04	Screw, 8-32 x 1/4" PHMS, SS
12	03-905584-00	Cable, RAM PS & Batt Back-Up to RAM
13	03-905629-00	Label, "Warning"

CRT/CHARGER MODULE ASSEMBLY DRAWING 03-905404-00





SIGNAL CIRCUIT BD
COMP. SIDE
(EXCESSIVE DETAILS OMITTED)

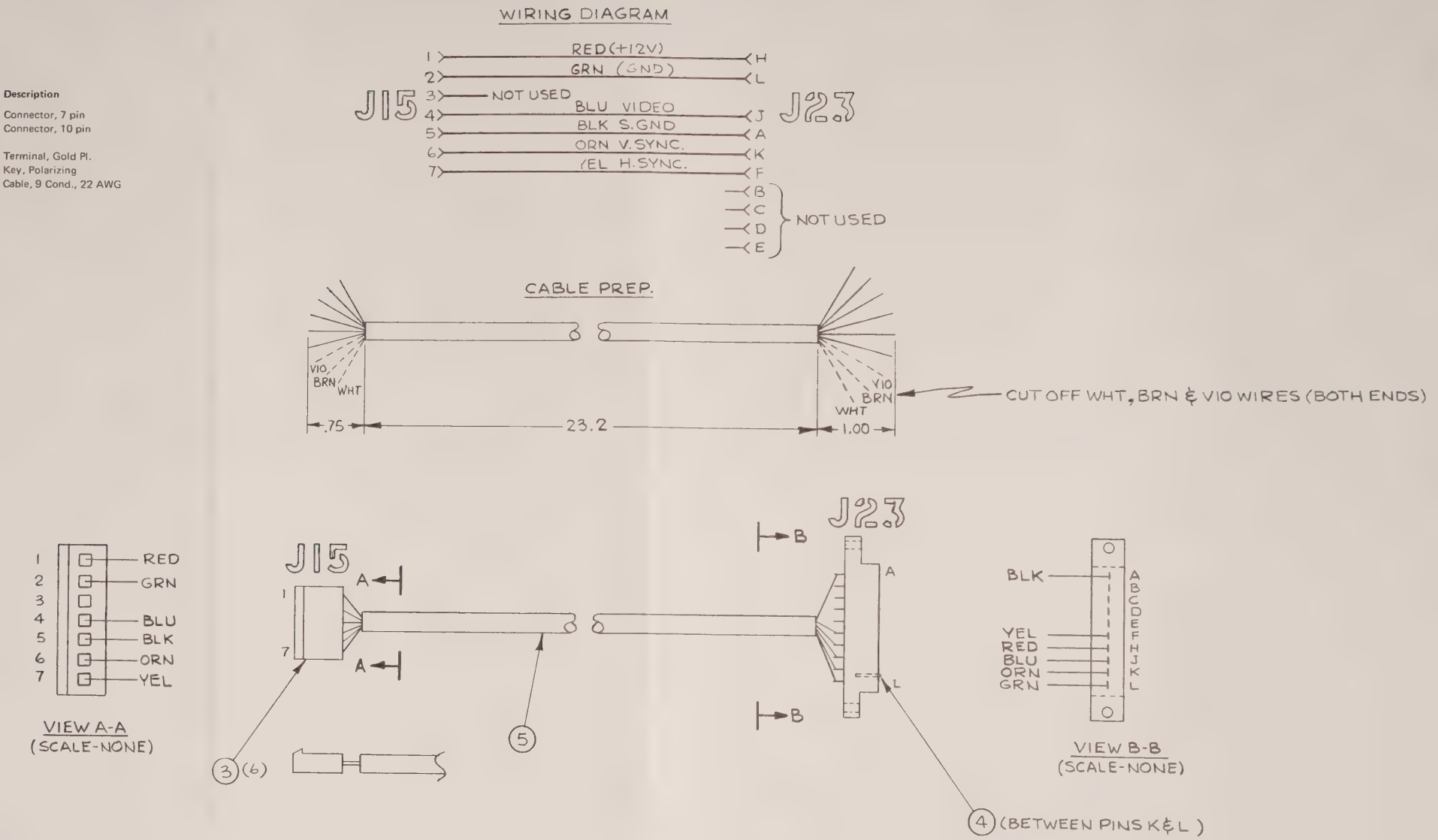


SIDE VIEW

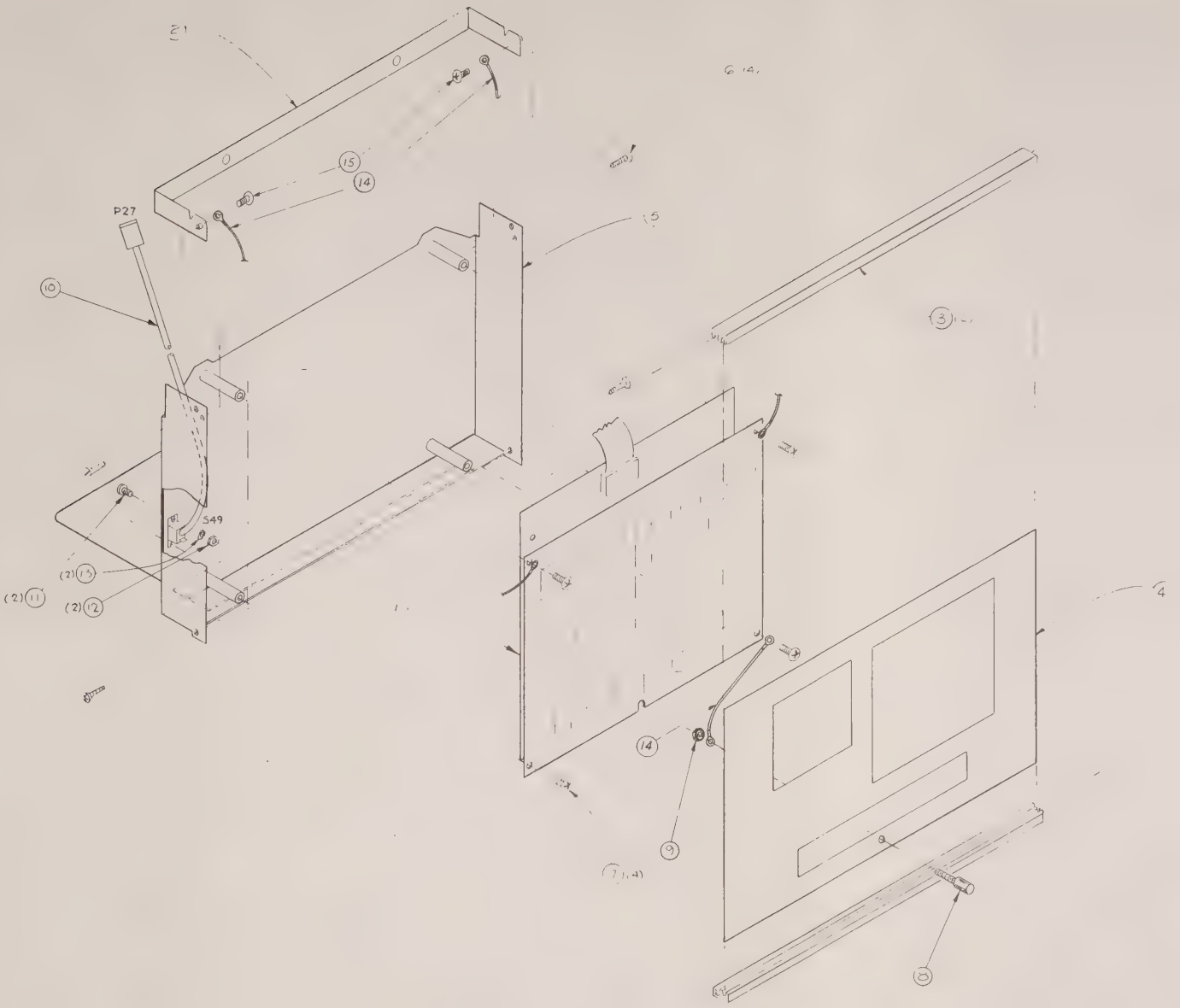
Schematic Reference/ Item No.	Part Number	Description
1	78-505000-00	Display, CRT (Motorola)
3	03-905464-00	Interconnect Cable Assembly
7	15-000210-00	Screw, 8 x 3/8 Hex Wash. HD
11	49-000017-00	Tie, Cable
12	14-312008-00	Washer, #8 Ext. Tooth, SS
14	03-905630-00	Tag, Instruction

MODIFIED CRT ASSEMBLY DRAWING
03-905614-01

Part Number	Description
51-407148-00	Connector, 7 pin
51-408410-00	Connector, 10 pin
51-407131-00	Terminal, Gold Pl.
51-960028-00	Key, Polarizing
81-813602-00	Cable, 9 Cond., 22 AWG

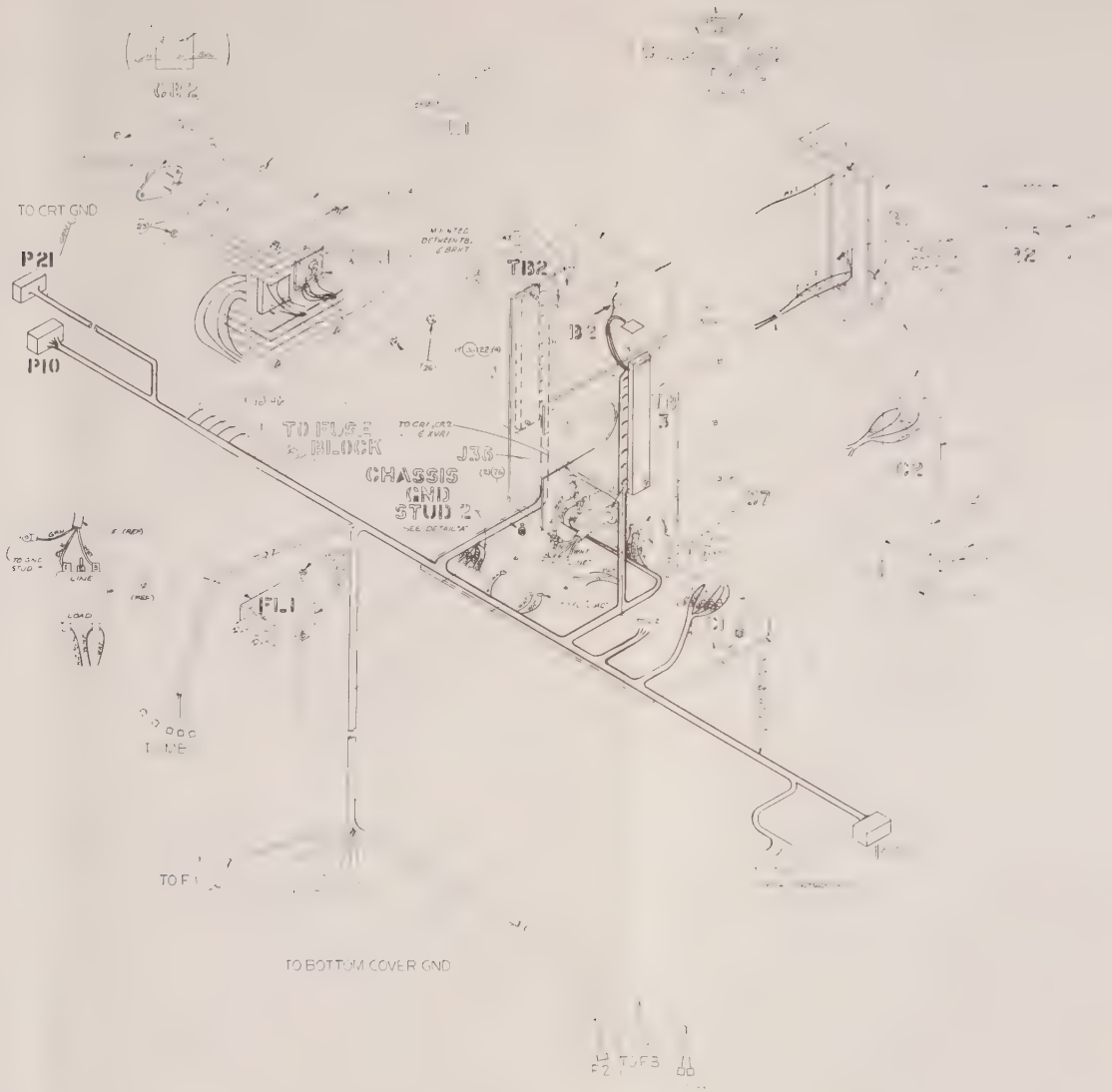


CRT INTERCONNECT CABLE ASSEMBLY DRAWING 03-905464-00



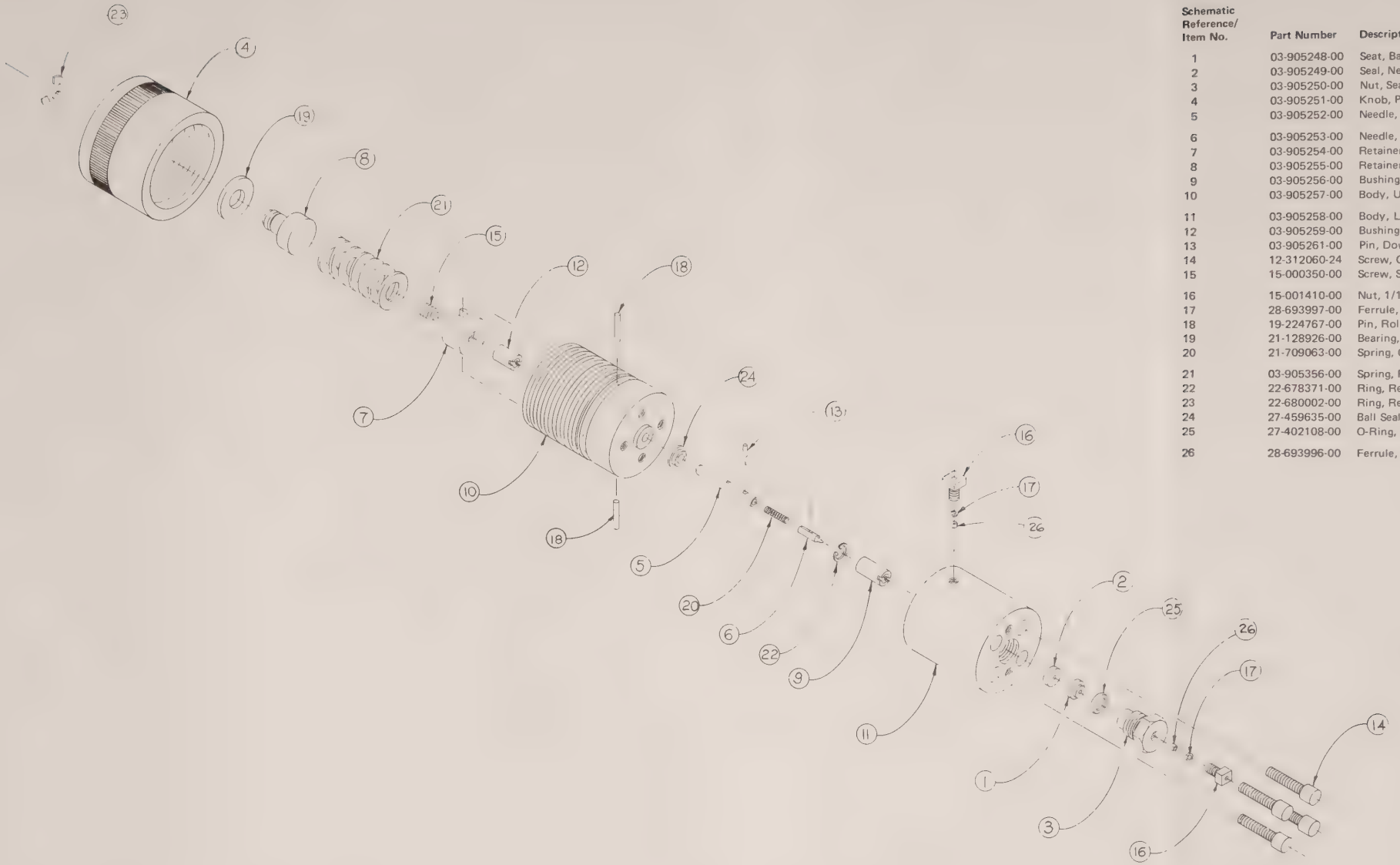
Schematic Reference/ Item No.	Part Number	Description
1	03-905421-01	Assembly, PCB, Keyboard
2	03-905478-00	Bracket, Housing, Keyboard
3	03-905480-00	Extrusion, Crossbar, Black
4	03-905481-00	Panel, Front, Keyboard
5	03-905488-00	S/A, Housing, Keyboard
6	10-441104-06	Screw, 4 x 3/8 Thrd Rolling
7	12-222006-06	Screw, 6-32 x 3/8 PH, SS
8	12-902874-00	Thumb Screw
9	13-310000-00	Nut, Kep, 6-32 Sm Patt SCD
10	03-905585-00	Assy, Remote Switch Keyboard
11	12-222002-04	Screw, 2-56 x 1/4 Long SS
12	13-102002-00	Nut, #2, Hex, SST
13	14-312002-00	Washer, Ext Tooth #4 SS
14	03-905466-00	Grounding Strap 2.75"
15	12-222006-03	Screw, #6-32 x 3/16 PH, SS

KEYBOARD ASSEMBLY DRAWING
03-905392-00



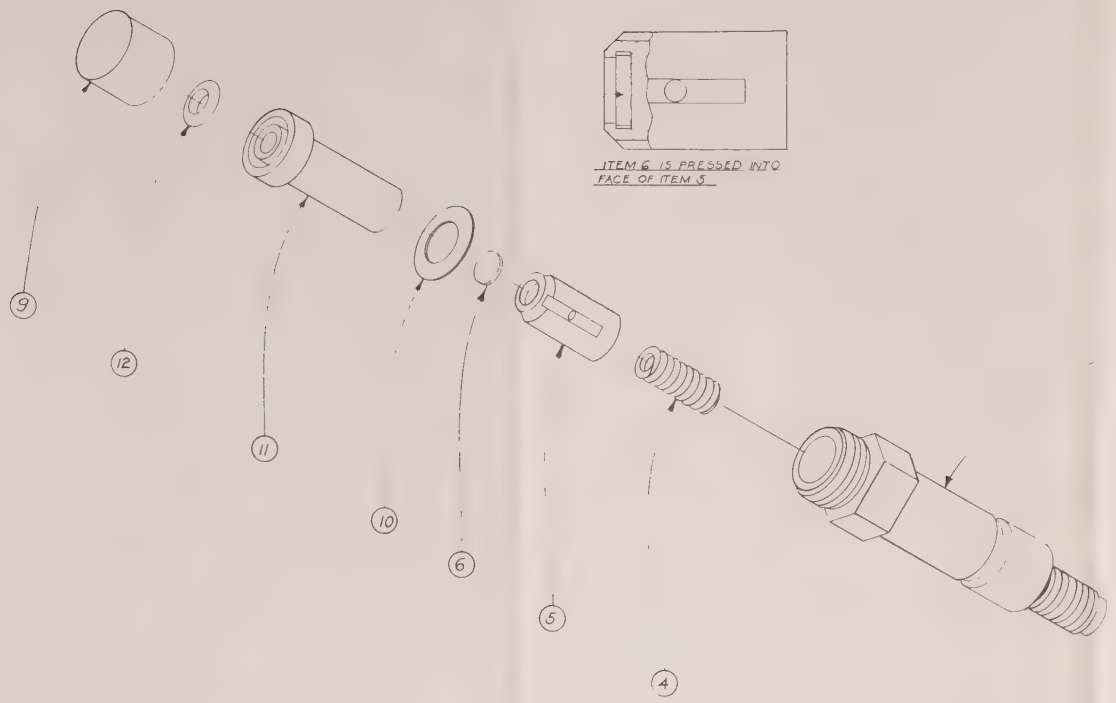
Schematic Reference/ Item No.	Part Number	Description
B2	18-000006-00	Fan, Axial, 115 CFM, 117 Vac 50/60 Hz, 20W
C1	41-516695-00	Capacitor, 27,000 μF, 15V
C2	41-515989-00	Capacitor, 40,000 μF, 50V
FL1	43-399863-00	Filter, Power Line, 230 Vac, 50-400 Hz
J36	12-000408-00	Receptacle, 15A, 125V
J37		Same as J36
R1	03-905472-00	Assy, Power Resistor
R2	34-401368-00	Resistor, Comp, 680Ω 2W 5%
VR1	62-600930-00	Regulator, +5V, TO-3 Type, LAS1905
1	03-905446-00	Assy, Harness, Mainframe
2	03-905454-00	Bracket, Power Distribution
3	03-905470-00	Assy, Heatsink, Power Dist.
5	03-905473-00	Assy, Power Cord
6	03-905501-00	Plate, Bottom, Power Dist.
7	31-000359-00	Label, Voltage Selection
8	03-905665-00	Label, Heaters & Ext. Events
16	08-000077-00	Clamp, Capacitor
17	06-000601-00	Clamp, Capacitor
18	15-000943-00	Bushing, Strain Relief
20	15-000835-00	Grommet, 1/2"
21	12-222006-03	Screw, 6-32 x 3/16, Ph, Phil, SS
22	12-222008-06	Screw, 8-32 x 3/8, Ph, Phil, SS
23	12-222006-08	Screw, 6-32 x 1/2, Ph, Phil, SS
24	10-331106-10	Screw, 6-20 x 5/8, Drive, Tapping, Ph, CPSTL
25	12-222006-26	Screw, 6-32 x 1-3/4, Ph, Phil, SS
26	15-001209-00	Nut, Kep, 6-32, SS
27	14-901021-00	Washer, Flat, #6, SS
28	51-000643-00	Term, Ring Tongue, 8-10, 22-18 GA
29	12-222006-10	Screw, 6-32 x 5/8, Ph, Phil, SS
30	12-222006-06	Screw, 6-32 x 3/8, Ph, Phil, SS
31	82-005750-00	Heatsink Compound, Silicone
32	03 000019-00	Bushing, Teflon
34	14-312006-00	Washer, #6 Ext. Tooth, Lock
35	14-302006-00	Washer, #6 Int. Tooth, Lock
36	14-312008-00	Washer, #8 Ext. Tooth, Lock

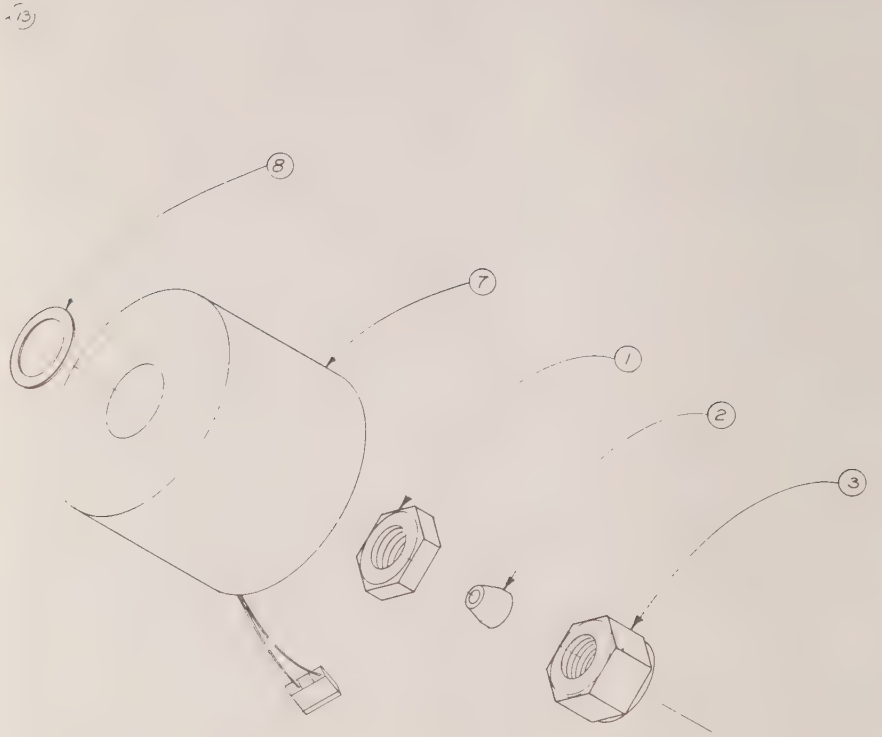
POWER DISTRIBUTION CHASSIS ASSEMBLY DRAWING 03-905445-00



Schematic Reference/ Item No.	Part Number	Description
1	03-905248-00	Seat, Back-Up, Pressure Regulator
2	03-905249-00	Seal, Needle, Pressure Regulator
3	03-905250-00	Nut, Seat Retaining, Pressure Regulator
4	03-905251-00	Knob, Pressure Regulator
5	03-905252-00	Needle, Outer, Pressure Regulator
6	03-905253-00	Needle, Inner, Pressure Regulator
7	03-905254-00	Retainer, Needle, Pressure Regulator
8	03-905255-00	Retainer, Thrust Bearing, Pressure Regulator
9	03-905256-00	Bushing, Lower, Needle Guide, Press. Reg.
10	03-905257-00	Body, Upper, Pressure Regulator
11	03-905258-00	Body, Lower, Pressure Regulator
12	03-905259-00	Bushing, Upper, Needle Guide, Press. Reg.
13	03-905261-00	Pin, Dowel, 1/16" OD x .160 Long, SST
14	12-312060-24	Screw, Cap, 10-32 x 1-1/2" Long, SST
15	15-000350-00	Screw, Set, 1/4 - 20 x 5/16" Long
16	15-001410-00	Nut, 1/16" Tube, SST
17	28-693997-00	Ferrule, Back, 1/16" SS (Swagelok only)
18	19-224767-00	Pin, Roll, .093 Dia x .50 Long, SST
19	21-128926-00	Bearing, Thrust
20	21-709063-00	Spring, Compression, .120 OD
21	03-905356-00	Spring, Pressure Regulator
22	22-678371-00	Ring, Retaining, Internal
23	22-680002-00	Ring, Retaining, External
24	27-459635-00	Ball Seal, .187 ID, Teflon
25	27-402108-00	O-Ring, 3/8" x 1/4" x .07 TK, Teflon
26	28-693996-00	Ferrule, Fr. 1/16" SS (Swagelok only)

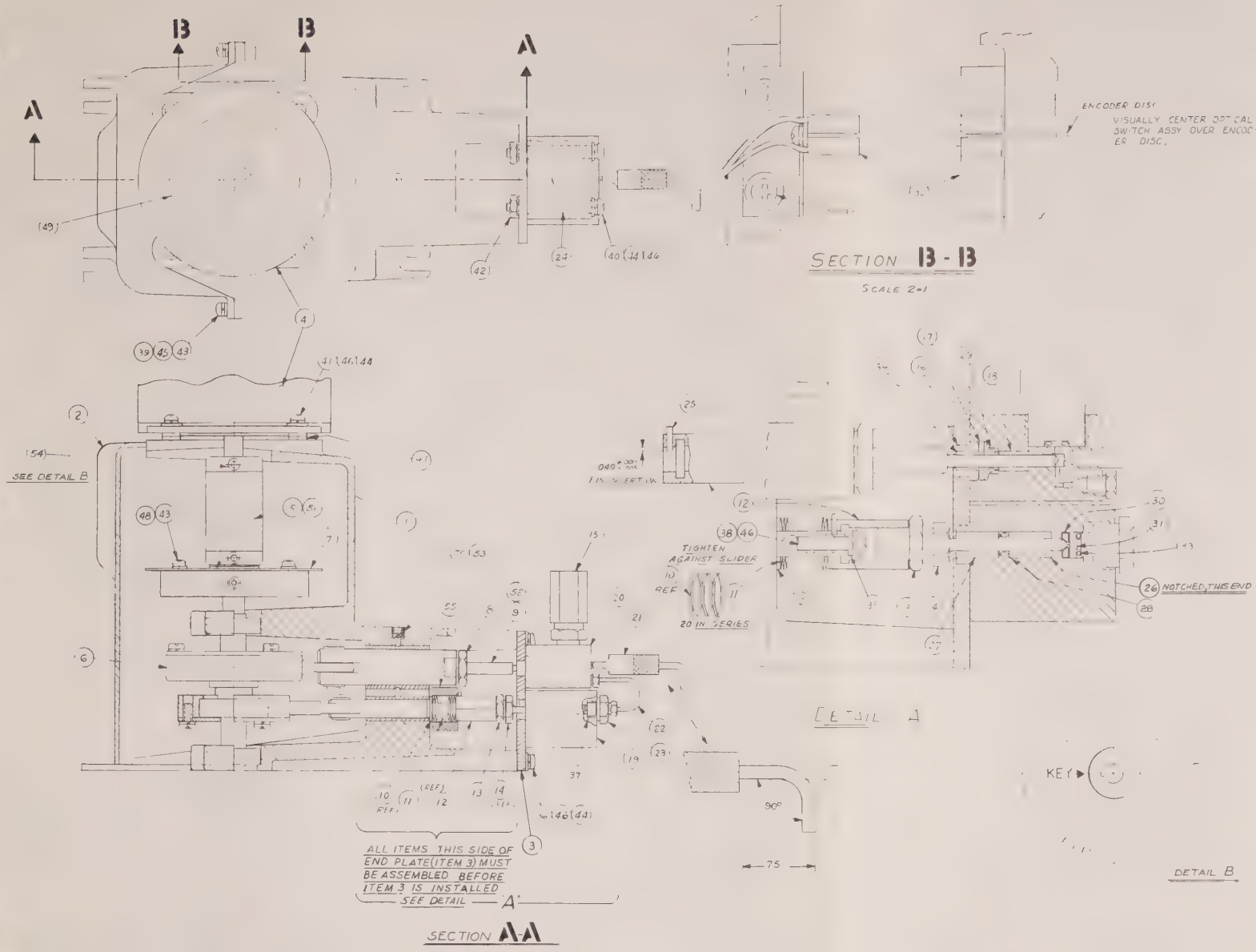
FLOW CONTROLLER
ASSEMBLY DRAWING 03-905260-00





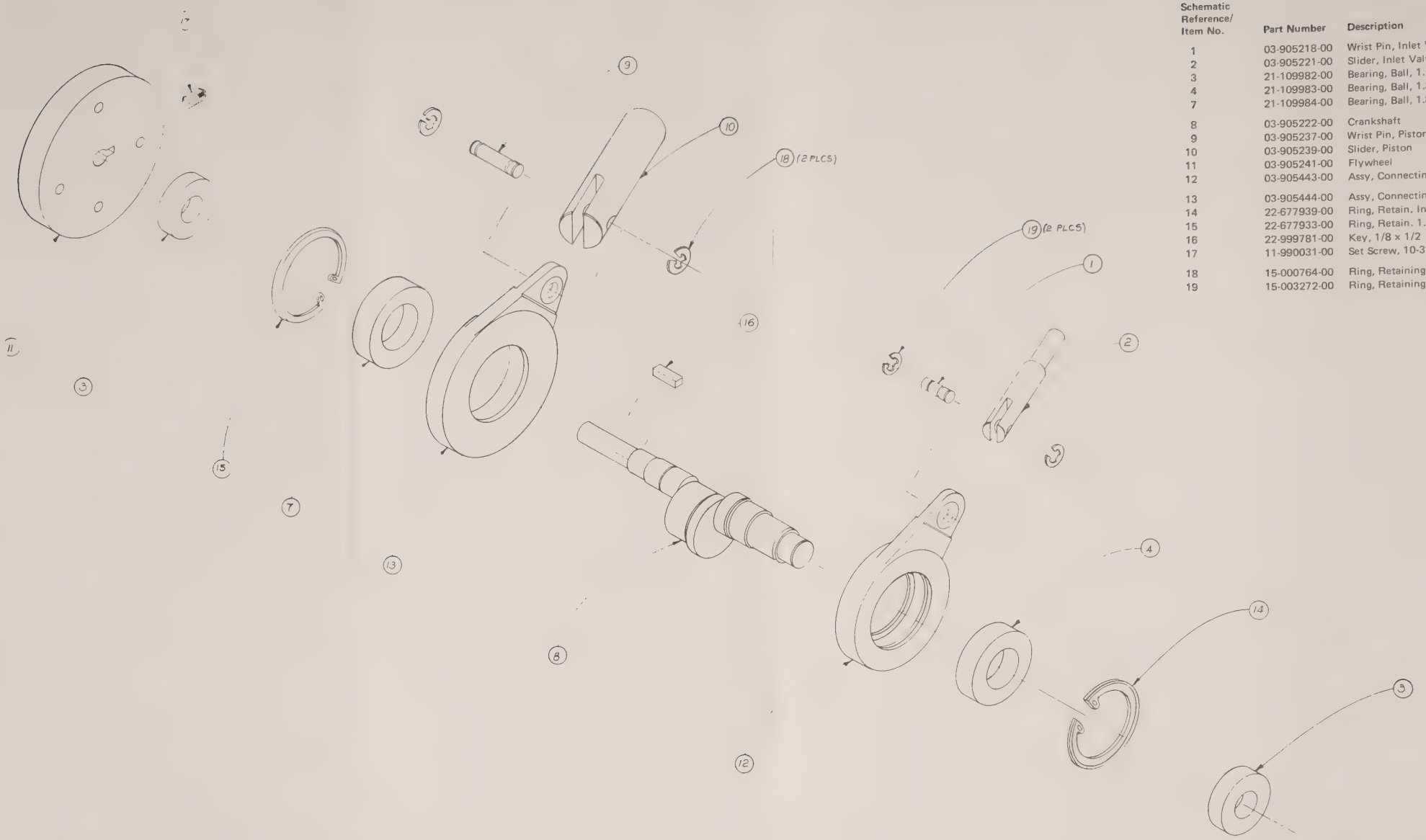
Schematic Reference/ Item No.	Part Number	Description
1	28-694507-00	Nut, Hex, 1/8" Tube, SS
2	16-000441-00	Ferrule, 1/8" Teflon
3	15-000632-00	Nut, 1/8" Tube, SS
4	03-905345-00	Spring, Prop. Valve
5	03-905267-00	Poppet, Prop. Valve
6	03-905266-00	Seal, Poppet, Prop. Valve
7	03-905663-00	Assy, Coil, Prop. Valve
8	03-905344-00	Shim, .63 OD x .38 ID
9	28-699985-00	Caplug, 7/16" Dia x 1/2" Lg
10	03-905341-00	Shim, Prop. Valve
11	03-905346-00	Orifice, Prop. Valve
12	27-402105-00	"O" Ring, .176 ID x .070W, Teflon
13	03-905354-00	S/A, Base, Prop. Valve

PROPORTIONING VALVE ASSEMBLY DRAWING 03-905263-00



Schematic Reference/ Item No.	Part Number	Description
1	03-905338-00	Assy, Pump Housing
2	03-905293-00	Casting, Pump Cover
3	03-905234-00	Plate, Head Mounting
4	30-000100-00	Motor, Step, Dbl-Ended, Modified
5	20-269921-00	Coupler, Flexible
6	03-905334-00	Assy, Crankshaft
7	03-905325-00	Disc, Encoder, Pump
8	03-905231-00	Nut, Piston Mounting
9	03-905337-00	Assy, Piston, Pump
10	14-900020-00	Washer, .255 ID x .50 OD
11	14-999688-00	Washer, Spring
12	03-905216-00	Nut, Overtravel
13	03-905224-00	Nut, Locking, Inlet Valve
14	03-905223-00	Needle, Inlet Valve
15	03-905201-00	Assy, Check Valve
16	03-905236-00	Collar, Locating
17	03-905319-00	Washer, Back-Up, Pump Piston Seal
18	03-905232-00	Bushing, Piston
19	03-905244-00	Head, Inlet Valve
20	03-905226-00	Head, Piston
21	03-905335-00	Assy, Needle, Bleed Valve, Pump
22	03-905225-00	Assy, Interconnect Tube
23	03-905245-00	Fitting, Interconnect Tube, Inlet Valve
24	03-905228-00	Stud, Head Mounting
25	19-224758-00	Pin, Roll 1/16 Dia x .250 SS
26	03-905238-00	Bushing, Inner, Inlet Valve
27	03-905355-00	Bushing, Outer, Inlet Valve
28	27-459632-00	Seal, Dynamic, .125 ID
29	27-459633-00	Seal, Dynamic, .125 ID, Flanged
30	03-905240-00	Seat, Inlet Valve
31	03-905242-00	Support, Seat
32	03-905336-00	Assy, Switch, Optical, Pump
33	27-402107-00	O-Ring, .114 ID x .07W Teflon
34	03-905230-00	Bushing, Outer Piston
35	03-905217-00	Washer, Overtravel
36	12-222008-00	Screw, 8-32 x 1/2, PHMS, Ph Hd, SS
37	12-312060-23	Screw, 10-32 x 1-3/8, Skt Hd Cap, SS
38	12-362008-08	Screw, 8-32 x 1/2, Butt Hd Skt, SS
39	12-222006-05	Screw, 6-32 x 5/16, Ph. Hd, SS
40	12-222008-05	Screw, 8-32 x 5/16, Ph Hd, SS
41	12-222008-12	Screw, 8-32 x 3/4, Ph Hd, SS
42	15-001212-00	Nut, 10-32, Kep, SS
43	14-901021-00	Washer, #6 Flat, SS
44	14-112008-00	Washer, #8 Flat, SS
45	14-212006-00	Washer, #6, Lockwasher, Split, SS
46	15-003202-00	Washer, #8, Lockwasher, Split, SS
47	14-999993-00	Washer, #8, Fiber 11/16 ID x 3/8 OD x 1/16 Thk
48	12-362006-06	Screw, 6-32 x 3/8 Butt Hd Skt, SS
49	79-000255-00	Damper, Step Motor
54	11-990032-00	Set Screw, Hex 1/4-20 x 5/16 Nylon
55	03-905558-00	Sleeve, Felt, Pump

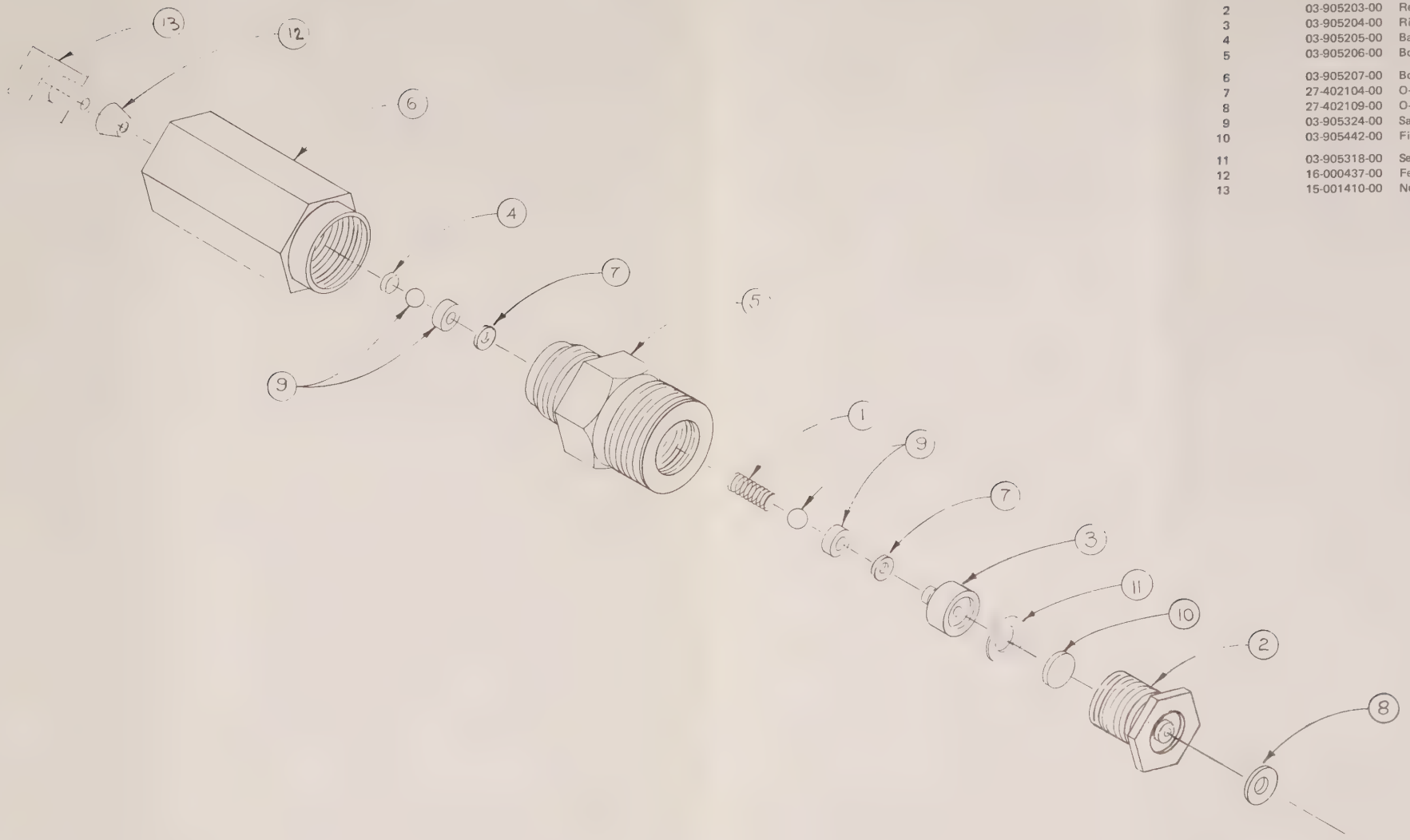
PUMP ASSEMBLY DRAWING
03-905333-00



Schematic Reference/ Item No.	Part Number	Description
1	03-905218-00	Wrist Pin, Inlet Valve
2	03-905221-00	Slider, Inlet Valve
3	21-109982-00	Bearing, Ball, 1.1024 OD
4	21-109983-00	Bearing, Ball, 1.3780 OD
7	21-109984-00	Bearing, Ball, 1.8504 OD
8	03-905222-00	Crankshaft
9	03-905237-00	Wrist Pin, Piston
10	03-905239-00	Slider, Piston
11	03-905241-00	Flywheel
12	03-905443-00	Assy, Connecting Link, In. Valve
13	03-905444-00	Assy, Connecting Link, Piston
14	22-677939-00	Ring, Retain. Int., 1.526 D x .050W
15	22-677933-00	Ring, Retain. 1.85 D x .050W
16	22-999781-00	Key, 1/8 x 1/2
17	11-990031-00	Set Screw, 10-32 x 3/8
18	15-000764-00	Ring, Retaining, Ext. 1/4" Shaft
19	15-003272-00	Ring, Retaining, Ext. .188 Shaft

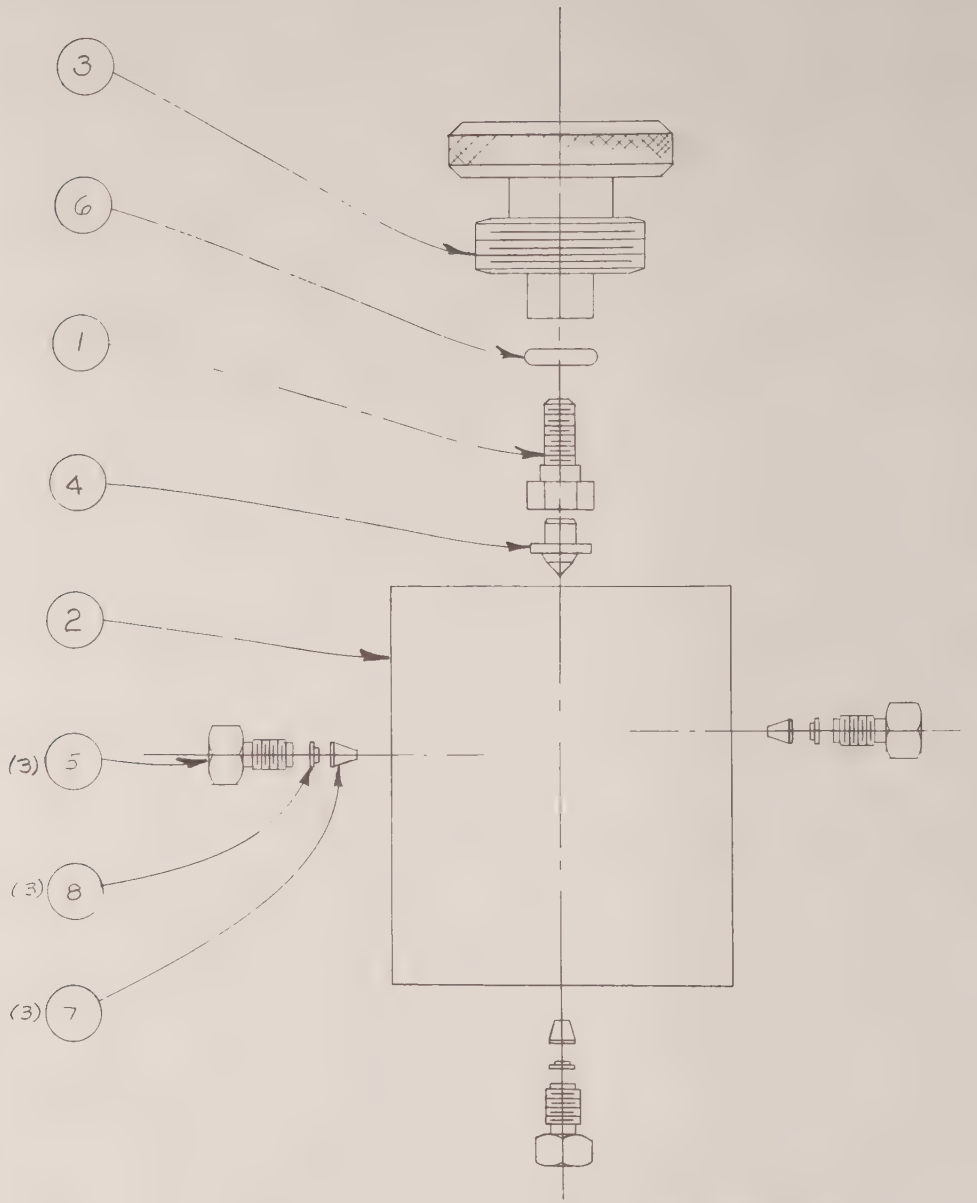
CRANKSHAFT ASSEMBLY DRAWING
03-905334-00

Schematic Reference/ Item No.	Part Number	Description
1	03-905202-00	Spring, Compression, Check Valve
2	03-905203-00	Retainer, Filter, Check Valve
3	03-905204-00	Ring, Back-Up Seal, Check Valve
4	03-905205-00	Ball Stop, Check Valve
5	03-905206-00	Body, Lower, Check Valve
6	03-905207-00	Body, Upper, Check Valve
7	27-402104-00	O-Ring, Teflon, .176 OD
8	27-402109-00	O-Ring, Teflon, .241 OD
9	03-905324-00	Sapphire Ball and Seat (Set)
10	03-905442-00	Filter, 2 Micron, Check Valve
11	03-905318-00	Seal, Filter, Check Valve
12	16-000437-00	Ferrule, 1/16 SS
13	15-001410-00	Nut, 1/16 Zero Dead Volume

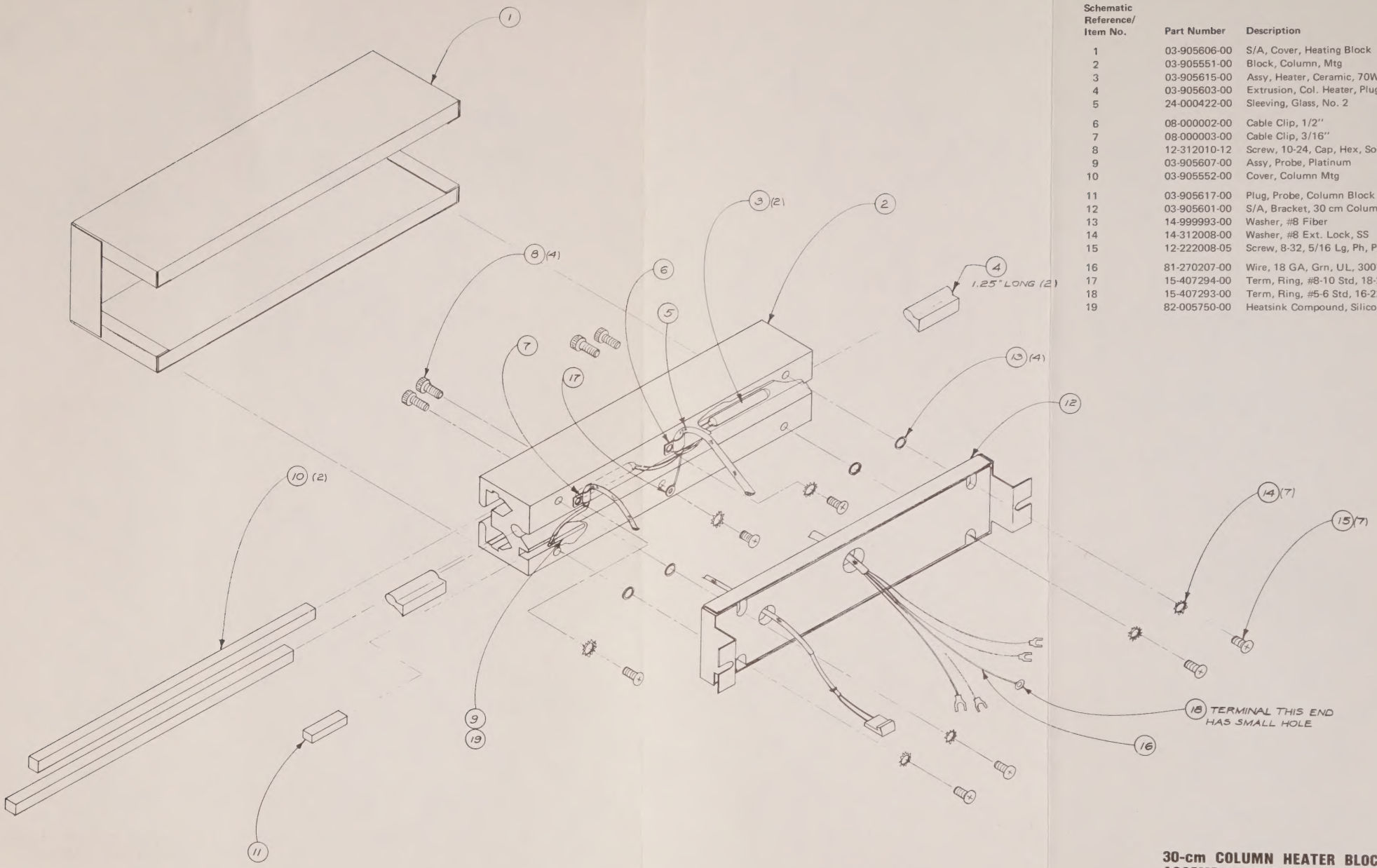


CHECK VALVE ASSEMBLY DRAWING
03-905201-00

Schematic Reference/ Item No.	Part Number	Description
1	03-905209-00	Retainer, Seal, Injector
2	03-905210-00	Body, Injector, Stop Flow
3	03-905213-00	Plug, Injector, Stop Flow
4	03-905347-00	Seal, Injector, Stop Flow
5	15-001410-00	Nut, 1/16" Tube, SS
6	27-402105-00	O-Ring, Teflon, .316 OD
7	28-693996-00	Ferrule, Front, 1/16" Tube, SS S/L
8	28-693997-00	Ferrule, Back, 1/16" Tube, SS, S/L

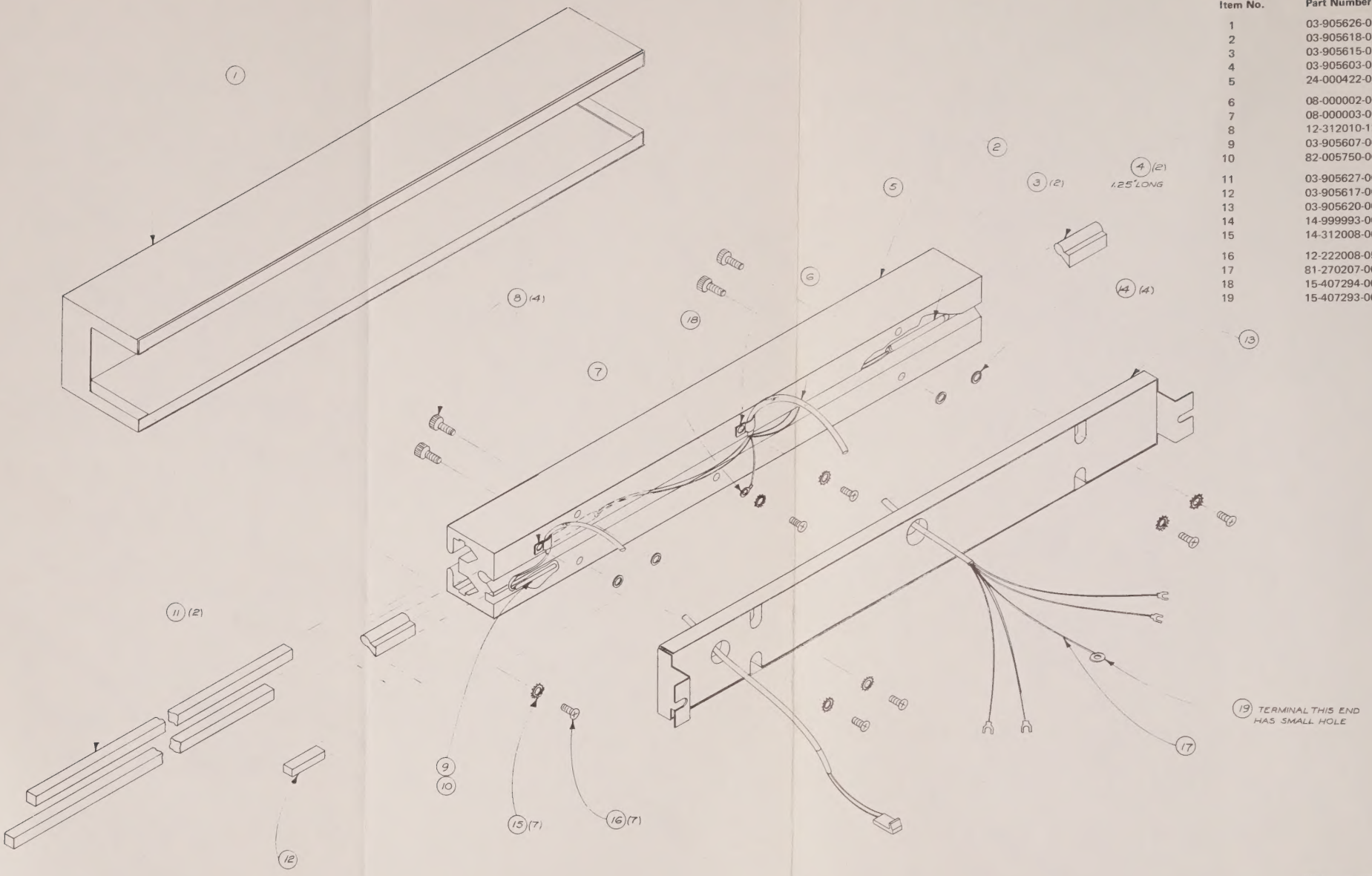


STOP FLOW INJECTOR
ASSEMBLY DRAWING 03-905208-00



Schematic Reference/ Item No.	Part Number	Description
1	03-905606-00	S/A, Cover, Heating Block
2	03-905551-00	Block, Column, Mtg
3	03-905615-00	Assy, Heater, Ceramic, 70W 115V
4	03-905603-00	Extrusion, Col. Heater, Plug
5	24-000422-00	Sleeving, Glass, No. 2
6	08-000002-00	Cable Clip, 1/2"
7	08-000003-00	Cable Clip, 3/16"
8	12-312010-12	Screw, 10-24, Cap, Hex, Socket, 3/4 LG
9	03-905607-00	Assy, Probe, Platinum
10	03-905552-00	Cover, Column Mtg
11	03-905617-00	Plug, Probe, Column Block
12	03-905601-00	S/A, Bracket, 30 cm Column
13	14-999993-00	Washer, #8 Fiber
14	14-312008-00	Washer, #8 Ext. Lock, SS
15	12-222008-05	Screw, 8-32, 5/16 Lg, Ph, Phil, SS
16	81-270207-00	Wire, 18 GA, Grn, UL, 300V
17	15-407294-00	Term, Ring, #8-10 Std, 18-22 GA
18	15-407293-00	Term, Ring, #5-6 Std, 16-22 GA
19	82-005750-00	Heatsink Compound, Silicone

30-cm COLUMN HEATER BLOCK ASSEMBLY DRAWING 03-905602-00



Schematic Reference/ Item No.	Part Number	Description
1	03-905626-00	S/A, Cover, Heated Block
2	03-905618-00	Block, Column, Mtg
3	03-905615-00	Assy, Heater, Ceramic, 70W 115V
4	03-905603-00	Extrusion, Col. Heater Plug
5	24-000422-00	Sleeving, Glass No. 2
6	08-000002-00	Cable Clip, 1/2"
7	08-000003-00	Cable Clip, 3/16"
8	12-312010-12	Screw, 10-24, Cap, Hex, Socket 3/4 LG
9	03-905607-00	Assy, Probe, Platinum
10	82-005750-00	Heatsink Compound, Silicone
11	03-905627-00	Cover, Column, Mtg
12	03-905617-00	Plug, Probe, Col. Block
13	03-905620-00	S/A, Bracket, 50 cm Column
14	14-999993-00	Washer, #8, Fiber
15	14-312008-00	Washer, #8, Ext. Lock, SS
16	12-222008-05	Screw, 8-32, 5/16 Lg, Ph, Phil, SS
17	81-270207-00	Wire, 18 GA, Grn, UL, 300V
18	15-407294-00	Term, Ring, #8-10 Std, 18-22 GA
19	15-407293-00	Term, Ring, #5-6 Std, 16-22 GA

50-cm COLUMN HEATER BLOCK ASSEMBLY DRAWING 03-905398-00

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MP MASTER

MA35189